RAILROAD GAZETTE

SATURDAY, SEPTEMBER 30, 1871.

Welch's Car Truck.

The engraving herewith represents a six-wheeled truck manufactured by the Harlan & Hollingsworth Company, of Wilmington, Del., which was designed by Mr. Ashbel Welch, President of the United Railroad Companies of New Jersey.

Very little explanation is necessary, as the chief novelty, that of the arrangement of the outside springs and bolsters, is very clearly shown by the engraving. It will commend itself, we think, to all master car builders and railroad men generally.

Railway Gauges.

[Paper read before the British Association at Edinburgh, August, 1871, by Mr. Robert F. Fairlie.]

I had the honor, last year, of reading before this Association a paper upon "The Gauge for the Railways of the Future," in which I pointed out the capacities of narrow-gauge lines, and showed how unfavorably our own railway system, as at present worked, contrasts with such lines when properly handled. The great truths I then put forward were too startling to be received without some degree of ridicule and incredulity; and although I announced them in the full conviction that sooner or later they would be fully acknowledged, I was then little prepared for the rapidity with which that acknowledgement has come.

The report of the Imperial Russian Commission upon the Festiniog Railway, produced a similar inquiry on the part of the Indian Government. I had once more the satisfaction of attending a Royal Commission, appointed to investigate the question of narrow gauge; and the results obtained on the second occasion were as satisfactory as those on the first.

In Russia, at the instance of His Excellency Count Bobrinskoy, His Imperial Majesty the Emperor commanded a line of narrow-gauge railway to be at once commenced, and a number of my engines to be constructed, in order that the accuracy of all I had asserted on the subject, and had shown to the Commission upon the Festiniog Railway, might be proved upon a more extended scale; and that the exact value of a narrow-gauge system, for national service, might be ascertained by the fullest tests of experience.

The Association will, perhaps, pardon a brief digression, while I here place on record, as a matter of history, the eminent services rendered to the cause of narrow-gauge extension by the Russian Commission, and also by Mr. Spooner, the engineer and manager of the Festiniog Railway. This little line, of only 1-foot 11½-inch gauge, was originally constructed for horse traffic; but was worked after a time by small locomotive engines, resembling, in everything but dimensions, those in common use in England. As thus worked, the traffic outgrew the carrying capacity of the line; and powers to construct a second track were actually obtained. At this conjuncture, Mr. Spooner had the sagacity to perceive the advantage that would accrue from the employment of my system of traction, of which he had read, and the determination to carry out his perception to a practical issue. I constructed for him the now well-known "Little Wonder" locomotive, and thus gave him, on his single line, two-and-a-half times the carrying capacity that he had possessed before. The second track was thus rendered unnecessary, and it has never been made. In the application of all novelties there must ever be risks of failure from unforeseen causes, and hence many, even when they recognise a truth, shrink from the responsibility of being the first to carry it into practice. The acceptance of this responsibility by Mr. Spooner, the opportunities that he thus afforded me of proving the working value of my principles, and the facilities for inspection and experiment that he has since courteously allowed, all fairly entitle him to be considered the father, as his tiny railway has certainly been the cradle, of the narrow-gauge system of the future.

The next step was made by the Russian Commission. It would be difficult for me to do justice to the infinite care and pains with which Count Bobrinskoy, the President of the Commission, investigated every detail before arriving at his conclusion, or to the earnestness with which he afterwards pushed this conclusion to its legitimate results. In Russia, as in other countries, there are men whose interests or whose prejudices lead them to cling to existing systems, and the opposition which proceeded from such persons could only have been overcome by the strength of clear convictions, of unsullied integrity, and indomitable resolution. Count Bobrinskoy was worthily assisted in his novel and important duty by the other members of the Commission, among whom I may name M. B. Saloff, Professor of the Technical School of Engineering, St. Petersburg; M. von Desen, now resident engineer in charge of the works; and M. Schoubersky, in charge of the rolling stock of the Imperial Livny Railway. To these gentlemen the entire civilized world owes a deep debt of gratitude. The line which was constructed and equipped in accordance with their report has now for several months been in operation. The results of its working establish all that I claimed for the narrow gauge; and the final official trials that will take place this month will determine the general adoption of the 3-feet 6-inch gauge in Russia, together with the employment of my locomotives, *without which the value of the narrow gauge at once sinks into comparative insignificance.* This rapid action is due to the promptness with which His Imperial Majesty of Russia appreciates progress, to his freedom from prejudice, and to the fact that I have never advanced anything which I have not been able to prove.

In India, although I believe ground has not yet been broken, a meter gauge has been decreed for general introduction; and the strongest advocates for the retention of the 5-feet 6-inch gauge have been entirely defeated.

In Australia, Tasmania, and New Zealand, narrow-gauge railways have been undertaken, and will be built as fast as means that have been straitened and opinions that have been prejudiced will permit.

In South America, to a great extent, and in North America—I speak of the United States—to a marvelous degree, the reform I have so long, and at last so successfully, advocated, is making way with an astonishing rapidity. Some 2,000 miles of narrow-gauge line are under construction; the great Denver & Rio Grande Railway, 850 miles in length, is being built upon the gauge I have made specially my own; and I may mention that this width of 3 feet was decided upon by the President and principal officers of the company after considerable investigation of the principles of my system recommended to their consideration by Mr. George Allan, C. E., who, at an early period, became strongly convinced of its advantages. A great transcontinental railway from the East to the Pacific is being organized, which, it is expected, will also be on the narrow gauge. California is building similar lines; the Western States and Territories—pastoral, agricultural, and mineral—are building them; Massachusetts, already covered with a network of ordinary-gauge railways, is legislating for them; and many others of the Eastern States are earnestly considering the advisability of their immediate construction.

As little as yourselves could I have last year imagined that all this progress would have been made in less than twelve months. At that time I was discouraged on almost all sides; I was hampered by the weight of prejudice and of opposition of every kind; but knowing that the work I had in hand was one which would benefit the whole of the civilized world—knowing that, could I once produce conviction, there need be no country, however poor, that could not be supplied, no distance, however great, that could not be traversed by profitable railways, I persevered, and to-day I find that my efforts have been crowned with a great and substantial success. Need I say that I appreciate this victory, counting the past pains as nothing, and being still more anxious to continue advocating the truth.

But it is only due to this Association that I should state how much of my success I owe to its influence, and to the weight thus added to my celebrated paper on "The Gauge for the Railways of the Future." To that paper I attribute a large proportion of the extraordinary activity that I have described. Stamped with the approval of this Association, the paper has circulated in all countries, and has been translated into all European languages, including those which have been naturalized in South America. It has formed the text for innumerable discussions; it is almost daily quoted in the journals of the United States; and it has excited the most lively interest among the railway engineers of that country, where existing railway management shows results still more discouraging than those which are obtained in England. The British Association, therefore, more than other public body, has helped forward a vast reform, and gratefully feeling this, I am encouraged to come here again on this occasion.

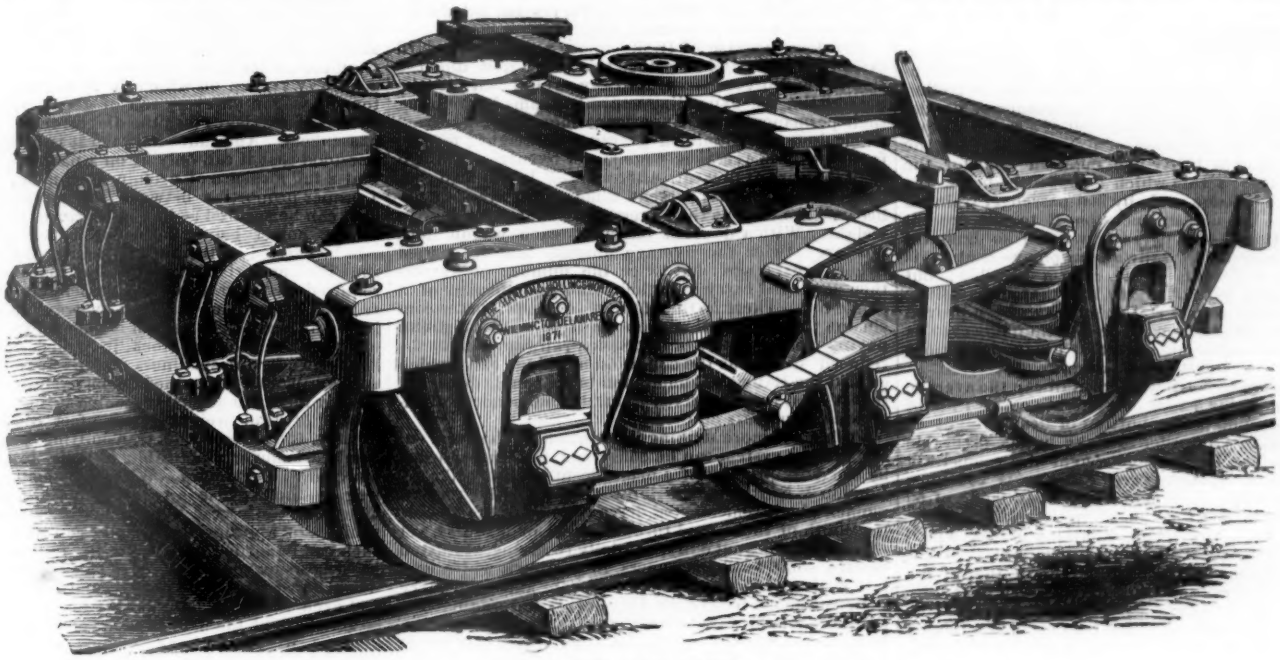
It is not long since, that to doubt established gauge was professional heresy. A type to which an accident had given birth, had come in course of time to be considered perfect; it was a superstition quickened into a religion. By degrees, after scores of thousands of miles of railway had been built, and hundreds of millions of pounds expended, it began to be seen that there was something still to be desired, and that it was ruinous to make railways for the service of remote districts yielding but small traffic, or in countries whose limited means and commerce could not justify large expenditure. By this time the great outlay which attended the labors of the earliest engineers—the outlay involved by heavy works to gain easy gradients—had been somewhat reduced, and with improved locomotive practice, steeper gradients and sharper curves became possible. Then came the very recent modification of making essentially light lines upon the standard gauge, conforming as much as possible to the natural contour—*surface lines*, as I was the first to name them in 1864. By adopting them the cost of construction was greatly reduced, and was brought somewhat more into proportion with the revenue to be derived.

But these improvements were but improvements upon a bad type, and real reform could not be effected whilst the width of gauge remained, while the rolling stock continued unaltered, and the locomotive rested unmodified.

Meanwhile, the history of railroad construction in England was slowly repeating itself, even in an exaggerated form, abroad, and particularly in our colonies, where the primitive types were perpetuated by the pupils of the old school of engineers. And here I may remark that the difficulties encountered in this country in railway reform have been faithfully repeated in our colonies—an illustration of cause and effect.

Gradually it became known that the ruinous practice of English engineers in Norway had forced the government of that country to adopt an entirely new type, *after the intermediate stage of light standard-gauge railways had been largely tested and abandoned*, and that for the first time a national narrow-gauge system was established. But this was done so quietly, and information filtered so slowly from that isolated country, that until quite recently only a few have known of the change, and still fewer have known, or have cared to inquire, about the practice followed or the results obtained.

Of course, exceptional and independent lines of very narrow gauge, established almost universally for mineral traffic, have existed for many years; but these, with the exception of the Festiniog Railway, do not enter into the question; on the contrary, indeed, their



WELCH'S CAR TRUCK.

small traffic capacities, as worked, have served the opponents of narrow gauge as arguments against innovation.

So matters stood when I, having convinced myself of the monstrous errors which cripple our standard railway system, and having learnt the capability of narrow gauge—which are yet scarcely understood even by the engineers who are advocating and constructing them—so matters stood when I first devoted myself to the effort of promoting the general introduction of narrow-gauge lines, and had the audacity to set myself up in opposition to long-established and deeply-rooted principles. At first the utmost concession I could obtain—a concession granted but by a few—was that for new countries, where railroads did not exist, or for poor countries, where traffic was light and uncertain, a narrow-gauge system might be adopted with some amount of advantage; but that its capacity and consequent utility were proportioned to its gauge; and that hence, as a natural consequence, not only must such lines as I recommended be located in districts where only a very small business actually existed, but where also the prospect of its increase were extremely remote. I knew the error of this opinion, for I knew the actual capacity of narrow-gauge railways under proper management; therefore I was encouraged to persevere until, as the circle of conviction widened, I was enabled to put my views to the test of actual and wide experience, and to stir into life the radical reform which to-day is spreading on every side, and which shall before long become general.

I showed you last year how, upon a railway costing one-third less than a line of an ordinary gauge, I could with equal dispatch carry such a traffic as that of the London & Northwestern Railway, with a saving of three-fifths of the dead load carried; and how in so doing I could effect a corresponding reduction in engine power, and consequently in cost of fuel, of rolling stock, of engine repairs, and of maintenance of permanent way. All this could be effected at a speed at least equal to the present speed of freight trains for the goods traffic, and at thirty-five miles an hour for the passenger traffic; a rate which is but little below the average of the mileage made by fast passenger trains in this country. We are so accustomed to the present condition of things—or, perhaps, we are so ignorant of the real elements of railway economy—that it is difficult to believe this great reform possible; but belief was more difficult a year ago than it has since become, now that all my statements have been proved to be incontrovertibly true. The question, however, is one of such radical importance, that I may once more devote a few words to its elucidation.

On the London & Northwestern Railway the average practice is to employ 7 tons of wagon to carry 1 ton of goods, but I assume the proportion of dead weight to be only four to one, in order to make out as favorable a case as possible. The average weight of a goods train on the London & Northwestern Railway is 250 tons, composed, in the proportions I have mentioned, of 50 tons of freight to 200 tons of rolling stock. (See diagram.) On the Livny (New Russian), 3-feet 6-inch Railway, on the other hand, the average gross weight of trains is 354 tons, or 104 tons more than that of the London & Northwestern, while the dead weight is only 94 tons. This proportion is also shown on the diagram. To carry this paying load of 260 tons on the London & Northwestern, 1,040 tons of wagons would be employed, or more than eleven times the weight required by my system. In all my arguments, I of course deal with general goods traffic only, exclusive of minerals. It may be urged against this comparison that the more favorable traffic conditions of the Livny Railway help the results; but it is sufficient to reply, first, that with the reduced gauge reduced weight of wagons in proportion to capacity is feasible; next, that the smaller wagon capacity is essential to economy; and third, that while rolling stock of the smaller class is certain to be loaded more nearly to its ultimate limits, the difference between the maximum load and the absolute loads obtained in practice are attended with none of the excessive cost inevitable on a 4-feet 8½-inch gauge. I would here call your attention to a most important fact in connection with railway goods traffic. The average load of merchandise carried by each wagon in this country is considerably less than one ton. Experience has proved that the exigencies of traffic in this country have settled this average, yet wagons of four times this capacity must nevertheless be provided. This fact of itself is sufficient to show that so broad a guage as the standard one is very excessive. With a narrow gauge this evil may be prevented, and if a higher average per wagon could not be attained, at least a far lower proportion of dead weight would result. This I have endeavored to make apparent in the diagrams, which show the average proportions of dead to paying weight on the 4-feet 8½-inch gauge, and on the 3-feet gauge; and I have also placed the load carried as the average by the standard gauge upon a train running on a 3-feet gauge, the varying proportions being well expressed by contrasted colors. The great economy in working, brought about by the causes enumerated above, would react upon railway business, and, in increasing it, would certainly raise the wagon average, *because the cost of carriage would be so much reduced.*

I think you will agree with me that I am no visionary, but have always spoken within the mark, making my position sure as I advanced, and asserting nothing that I could not prove in actual practice. I have obtained, by the development of my system, results very closely approximating to those I stated last year—namely, three to one of paying to dead load; and I know that this proportion can and will be reached when my views are fully carried out, when a Fairlie gauge is worked with Fairlie locomotives and stock; while by no other system in existence can such results be obtained.

In the report of the Royal Railways' Commission, published in 1867, the following pregnant conclusions were arrived at from the opinions of the principal engineers and railway managers in this country: "*The only way in which an increased receipt in proportion to the cost of running the trains can be anticipated, is in carrying a larger number of passengers in proportion to the number of passenger carriages in the train, and running the goods trucks full instead of partially full; or, in other words, obtaining a greater amount of work out of the engines and carriages than at present. But this means that the passenger trains would be less frequent and more crowded; that the passengers going on to branch lines would have to change carriages more frequently; and that goods would have to be retained until full truck loads were made up, which would result in a slower delivery of goods.*"

So that, as the necessities of traffic enforce frequent passenger trains, three or four times the necessary weight of carriages must be provided; and as goods cannot be detained until trucks are fully loaded, it follows that universal extravagance is inseparable from the present system. Railway managers, who are of course thoroughly conversant with the subject, agree that our existing railways are at present being worked to the best advantage. If so, it cannot be doubted that there is a grave blunder somewhere; and if this blunder is not to be discovered in management we must seek for it in construction, and there we shall find it. We shall find that railways of the existing gauge will labor under disadvantages for all time; they will remain oppressed by the curse of dead weight, an evil from which they can by no means be relieved; dead weight in their rolling stock for passengers, one ton of which requires thirty tons to convey it; dead weight in their rolling stock for freight, which can never be more than one-quarter fully loaded; and dead weight in their locomotives, ill applied for obtaining useful results, but always destructive to the permanent way.

Nor does increase of traffic upon a great standard railway system tend to reduce this evil; if it did, the London & Northwestern Railway would not at the present time be expending enormous sums in doubling their permanent way. Experience shows that increased traffic does not diminish averages of weight; for the fact that these averages were larger twenty years ago than they are at present, although the traffic had not then reached half its present dimensions, was simply because the wagons then averaged about a ton less in weight. With a doubled business, each wagon does not carry twice the average amount that it carried twenty years ago; but twice the number of wagons then employed carry each their usual complement of a single ton. There is, therefore, no escape from the conclusion that the existing proportion of dead weight to paying weight upon a 4-feet 8-inch railway cannot be reduced so long as the condition of things exist which guided the Railway Commission to its conclusions, but that it must remain a fixed quantity independent of increase of business on the line.

I think no more striking illustration of the error of our present system can be conceived than is afforded by the daily practice of a magnificent company like the London & Northwestern Railway, who, at the present moment, be it remembered, have commenced to double the width of their road through press of business, yet who are sending out daily, and daily receiving, at Euston Square, some 4,400 passengers, in carriages which contain sitting accommodation for 13,500; and who carry their enormous freight in increments, averaging less than one ton, in wagons having six times that capacity. Imagine the amount of capital sunk before this result was obtained! Conceive the waste of engine-power, the wear and tear of rolling stock, the destruction of permanent way, the cost of staff, all entailed by this curse of dead weight; and then imagine how easily all this unmechanical and unbusiness-like state of affairs might have been prevented by the simple adoption of a suitable rolling stock running on a suitable gauge! I am not for a moment advocating any radical change in our English railway system; that system has outgrown the season of radical reform, and we must make the best of it as it is; but I seek to prevent the repetition elsewhere of mistakes that have been so costly here. I want to prevent the unnecessary extension of a system that is palpably false, but which is not on that account the less strongly defended and protected.

That our great error was known some years since to all thinking engineers, is shown by the quotation I just now made; Mr. G. P. Bidder stated before the Royal Commission: "*That great economy may yet be obtained in the transport of minerals over long distances by means of railways laid out under conditions admitting of very long trains being run.*" In this statement I find the very essence of the question at issue between myself and all conservative engineers; I find the necessity for reform acknowledged, and the means of attaining it hinted at by my warmest opponent. Except that his views did not extend to passengers and goods, but were confined simply to the transport of mineral traffic, we have a complete statement of the problem which I have brought successfully to a solution. The requirements which Mr. Bidder hinted at generally, I have worked out in detail, and have extensively reduced to practice, with results that show his judgment to have been sound as far as it went. The conditions under which a railway should be laid out to meet these requirements are clearly not those which rule the present system; ample experience proves the contrary, showing that no line, however full of business, can be worked to its full capacity. We are led then, unmistakably, to a narrow gauge, to the adoption of passenger carriages which shall be filled, of wagons which shall be almost fully loaded, and of weight which shall bear a reasonable proportion to their capacity, and we are led to the adoption of very long trains and powerful engines. Considering the date of Mr. Bidder's opinions, they could not have been put more clearly or more concisely.

To a certain extent, but in a very limited and imperfect degree, experiments were made in the direction indicated—faint foreshadowings of the practice now being so widely introduced—by an attempt to convey extremely heavy trains by means of an auxiliary pair of cylinders placed under the tender of the engine and receiving steam from the boiler; the idea being to utilize all the available weight of engine and tender for adhesion. In running expenses, the results of these trials were very satisfactory, showing a large reduction of cost in carrying the heavier load. There were many reasons why this arrangement should prove unsatisfactory, but I quote the results obtained, because they will not be called in question, and because, if so much economy could be obtained by such a contrivance as the steam tender, I may at least claim proportionately advantageous results for the system of which this was an indication.

Thus, with an ordinary engine, the cost of conveying a load of 210 tons was 20d. per mile, whilst the cost of conveying a load of 310 tons by the aid of the steam tender was only 23d. per mile. It is obvious that no such saving as this could have been effected had two independent engines been employed upon the same duty. The results clearly prove that a large saving can be effected by increased engine power and greater loads; but, as I have already pointed out, this economy cannot be realized on railways of the standard gauge; but on the many thousand miles of narrow-gauge railways that will before many years be constructed, the true system of economical working, developed by me, will not only be possible, but will be universally acknowledged and adopted.

It would seem a very simple and self-evident fact that the means of conveyance should be fairly proportioned to the amount to be conveyed, and I have been laboring for years to make people understand this. One would think it would be sufficient to point out, to countries contemplating the construction or the great extension of railways, and looking to England and English practice as a model, that the best labors of our engineers, after thirty years' experience, have given us a railway system on which it is necessary to have 4 tons of wagon for every ton of goods, and from 10 to 30 tons of carriages (see the diagram) for every ton of passengers. And indeed abroad it is pretty widely understood that it can only be on a narrow-gauge railway that a full measure of usefulness can be obtained, and a proper proportion between paying and non-paying load can be secured;—this is because the amount of engine power being unlimited, better paying trains can be carried on the narrow than on the broad gauge; the difference arising from the fact that the dead weight required for the transport of passengers and goods is reduced in the manner shown by practice and indicated in the diagram. The reform is effected by the adoption of a suitable rolling stock, in which dead weight is kept down by the smallness of the gauge, but in which ample capacity is obtained. Such carriages and wagons exactly meet the difficulty, which is one of the great causes of dead weight on a 4-feet 8½-inch gauge—namely, the necessity of transmitting passengers and goods, whenever practicable, to their destination without change of vehicles. With the small carriages and wagons, the expense attending this proceeding is reduced to the lowest possible cost, because, though vehicles of appropriate capacity can be employed, and each can be loaded almost to its full complement of passengers or goods, carriages half or two-thirds empty would never form necessary accompaniments to a train; and even if it were not possible in practice to place a larger share of the load in each vehicle than the present average, we should have wagons of 5 tons capacity weighing 1½ tons, instead of others weighing 4 tons to carry the 1 ton average.

This capability of sub-division of traffic is one of the most important advantages which the narrow gauge offers; it involves the leading principle in railway economy, but it is an economy which I have shown—and I am borne out by all the weight of the evidence given before the Railway Commission—to be impossible on the broad gauge.

But it must be remembered—and this is a point not understood by some of the strongest advocates of narrow gauge—*that such lines are of but little avail, unless they are provided with suitable locomotive power.* If a line is made in all respects a miniature copy of a broad-gauge railway, with miniature rolling stock and miniature engines, *its utility decreases, and its working capacity goes down, but its working expenses go up.* In illustration of this I may quote the results of Norwegian practice, where one of the narrow-gauge lines, carrying only a very small traffic as compared with that conveyed upon a broad gauge in the same country, shows its expenses to be out of all proportion; while the percentages of the expenses to the receipts vary from 65.47 to 103.5 on the various narrow-gauge lines now built in Norway, a result that cannot be considered favorable.

If we look at the capacity of the engines on these railways, we shall see that they are capable of drawing, besides their own weight, 83 tons, 55 tons, and 84 tons, respectively, up gradients of 1 in 70, 1 in 42, and 1 in 60, and it is worth noting that the proportion of working expenses to receipts *decreases as the power of the engine increases.* Although many other causes besides those of mere locomotive expenditure step in to interfere with results, the regular proportion is, I think, too clearly marked to be independent of this most important question. The capacities of the Norwegian stock and the maximum trains conveyed by the engines are shown in the diagram.

I refer again for a moment to the results obtained by the employment of the steam tender for dragging great loads. Mr. Sturrock found that he could, by adding a pair of steam cylinders to the tender of a locomotive, convey trains weighing one-half as much again as the maximum load carried by ordinary engines, with an extra expenditure of about 15 per cent.; and a train of any given weight can be conveyed for from 64 to 70 per cent. of the cost of such a train divided into two equal parts, which means a saving in the locomotive accounts of from 30 to 36 per cent. It is argued against me that an engine of my system is no more useful or profitable than two engines coupled together. My experiences prove the contrary; so far as they go, the

results with Mr. Sturrock's contrivance bear me out, and so do the results obtained by the working of MM. Meyer's (adapted from my own) in France.

If such a system as that which I recommend had been introduced into Norway, it is needless to point out that a considerable modification of the balance sheet would have been the result.

To sum up, then, the requirements necessary for making a narrow-gauge railway perfectly efficient, we must have light, small stock, easily handled, and very powerful engines, capable of drawing heavy loads. The experience of the present year entirely bears out this assertion. We need only turn to the 3-feet 6-inch Livny Railway in Russia, carrying regularly its 354 tons of train exclusive of engine, a duty accomplished by one Fairlie locomotive without distress to the permanent way, and up gradients some of which are 1 in 80, of 4 or 5 miles in length, and with an economy shadowed forth long since by the crude appliances that were tried with a vague hope of achieving a similar result.

Again, as already stated, the introduction of the same system on the Festiniog Railway avoided the necessity of doubling the line of rails (a work which was actually commenced so far as preliminaries were concerned), by more than doubling the utility of the single pair. The diagrams show the change very strikingly, the one indicating the daily duty of the "Little Wonder," the other the similar duty of the ordinary engines of rather more than half the weight.

It now remains to point out as briefly as possible the circumstances that have led me to adopt a 3-feet gauge and to recommend that width for general introduction.

Experience has shown that 3-feet 6-inch can be made a highly economical and efficient width; but it does not by any means follow that it is the most serviceable and most efficient, any more than it follows that the accidental 4-feet 8½-inch was all that could be desired, even though an act of Parliament had made it an article of belief.

On the contrary, as our knowledge and experience increase, we are enabled to approach more and more nearly to that happy mean, on either side of which is error. While, on the one hand, there is every necessity for obtaining such a gauge as will afford a good and useful width of vehicles, on the other it is necessary to avoid such narrow limits as would necessitate the introduction of too great overhang on each side of the rails. The 3-feet gauge appears to me to comply with all the necessary conditions better than any other, and it is from no mere theorizing that I lend all the influence I have towards its adoption. There is a certain amount of saving in first cost as compared with the 3 feet 6 inches, not a large amount, but worth considering. This, however, I leave out of the discussion for the present. The all-important matters are to place upon the rails a thoroughly efficient stock that shall possess a maximum of capacity and a minimum of weight, and to supply engine-power under the most economical circumstances, and I hold it to be easier to accomplish these objects on the 3-feet gauge than any other.

I am led to this conclusion both by a comparison of the actual work done on the railways of the 3-feet 6-inch gauge with that which can be accomplished with the 3-feet gauge, and because, having in view the practical requirements of goods traffic, I find that I can obtain an ample floor area with less dead weight than can be secured with any other width: *on a wider gauge the dead weight increases, on a narrower one the capacity diminishes.* A statement of the actual results of comparison will explain this more clearly and more quickly than could be done otherwise. On the Queensland 3-feet 6-inch Railway, the composite passenger carriages are 6 feet 6 inches wide and 6 feet high inside. The capacity is equal to 34 persons, and the weight is 10 tons 5 cwt., or 6 cwt. per passenger; the second and third-class carriages accommodate 48 persons, and weigh 9 tons 2 cwt., or 3.75 cwt. per passenger. The wagons average 14 feet in length, 6 feet in width, and weigh 3 tons 5 cwt. The covered wagons are 6 feet high inside, and the open wagons have sides 30 inches high; the first would have a capacity of about 7 tons, the latter of about 5 tons, the respective proportions of paying load to weight being 2.15 to 1, and 1.54 to 1.

On the Norwegian 3-feet 6-inch lines, the first-class carriages are 6 feet 10 inches wide outside and 20 feet long, weigh 4.6 tons, and carry 32 passengers, the proportion of weight per passenger being 2.9 cwt.; the second-class carriages have the same length and width, carry 32 persons, and weigh 2.4 cwt. per passenger. The covered goods wagons are 18 feet long, 6 feet 7 inches wide outside, weigh 3.7 tons, and carry 5 tons, the proportion of freight per ton weight of wagon being 1.2; this proportion is steadily maintained throughout, the wagon stock rising, however, as high as 1.6 to 1, while some of the more recent stock carries 6 tons instead of 5; of the increase of dead weight in these I have no data.

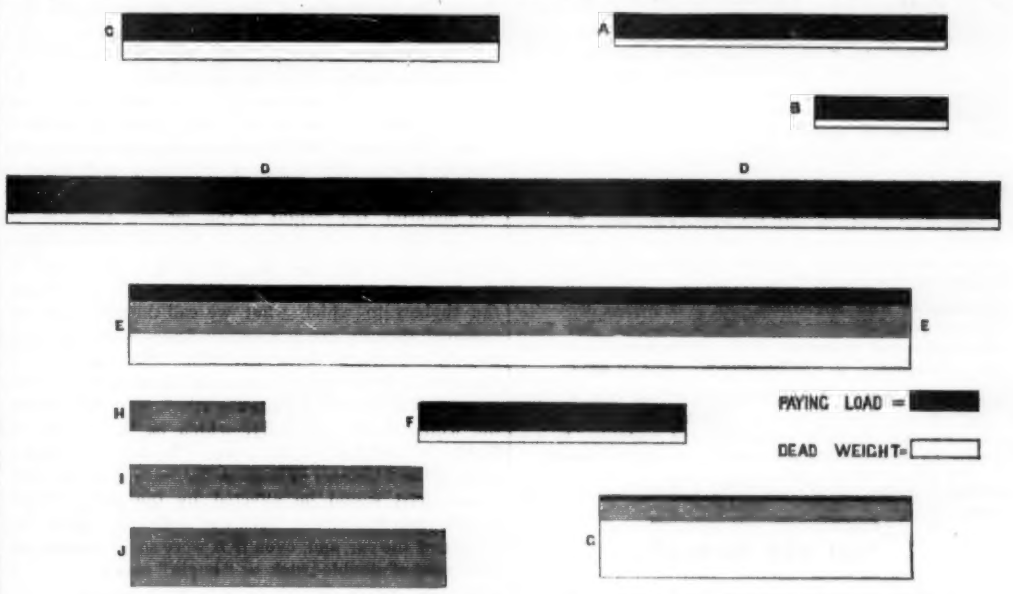
For a 3-feet gauge the stock that I construct is as follows: For first-class passengers the carriages are 18 feet 6 inches long, 6 feet 8 inches wide inside, seating 18 passengers, and weighing 3 tons 5 cwt., or 3.6 cwt. per passenger. For second-class, the carriages are 16 feet 6 inches long, 6 feet 8 inches wide, weighing 3 tons, and carrying 24 passengers, being 2.5 cwt. per passenger; the third-class carriages are of similar size, but seat 30 people, the dead weight being 2 cwt. per passenger. It will be noticed that these proportions are nearly identical with those on the Norwegian lines, but considerably less than those of the Queensland Railway.* My open wagons are 10 feet by 6 feet 6 inches by 2 feet 10½ inches high, weighing 28 cwt. 3 qrs., and having a cubic capacity of 4 tons, equal to a proportion of 3 to 1; also others for light goods, such as cotton, are 14 feet by 6 feet 6 inches, with posts and rails 6 feet 6 inches high from floor, or, as we are now running them in Mexico, with a low ledge running all round only 6 inches high, on which cotton bales are piled in a similar manner to that on a street wagon or lorry, and covered with tarpaulin. The covered wagons are 10 feet by 6 feet 6 inches by 6 feet, of 360 feet contents, and weighing 33 cwt., equal to 3 tons of carrying capacity to 1 of dead load. In all this stock, as well as in the other classes required, the center of gravity is kept low, and an angle of stability of 38° is in all cases maintained. It will thus be seen that upon a 3-feet gauge I am enabled to place stock of ample size and of less weight than can be done on the 3-feet 6-inch lines. In adopting this stock, I secure several advantages inseparable from the Fairlie gauge. The principal of these are: the reduced width between the sole bars for the under frames of wagons and carriages, and lengths of wheel centers; these in turn affect the scantlings of material, the weight of the wheels, the size of axles, to carry certain loads. It has been argued that the excess of strength over the actual requirements for carrying, but necessary to resist the shocks and concussions incident upon shunting, etc., would not be affected by the gauge; and that if the gross weight of a train is maintained upon the narrow that is now worked on the broad gauge, the wagon frame and couplings must be alike in weight to give equal strength to withstand sudden shocks and strains. Of course this is in itself quite true, and certain parts must be as strong in a train of given weight on a narrow as on a broad gauge. The force of the argument falls to the ground, if we remember that under present circumstances an average goods train, say of 250 tons, has only 50 tons of paying weight, the remaining 200 tons being stock. Now, on the narrow-gauge, supposing that only one ton of goods was carried per truck, as in the case of the 4-feet 8½-inch gauge, the dead weight required to carry it on my system would be only 87½ tons, making the total weight little more than half, and reducing the force of shocks upon the train in a proportionate manner, so as consequently to reduce the requsite weight of parts. Take, now, this same weight of paying load in a train, namely, 50 tons, and place it in the same portions in the wagons of the Norwegian 3-feet 6-inch line, or in those of the Queensland Railway, and we shall find that the dead load runs up to 185 tons, or a close approximation to our English practice. Probably, therefore, this stock as built is not too heavy to resist the strain and shocks thrown upon it by reason of its own weight; but by the mode of coupling employed on the Fairlie stock, the destruction arising from the shocks caused by sudden stopping and starting of the trains, especially when shunting, is entirely avoided, and as the strength and consequent weight of the present stock depends on the necessity of resisting these shocks and bumps, it follows that the instant these are removed the necessity for all this extra strength and weight is removed also.

The foregoing figures really mean that to carry 50 tons of goods on the Norwegian or Queensland 3-feet 6-inch gauge, the proportion of one ton per wagon being preserved, 92 per cent. of the weight of rolling stock used on the 4-feet 8½-inch would be required, as against only 43 per cent. on a 3-feet gauge; showing a saving of 47 per cent. on the latter as compared with a 3-feet 6-inch, as shown in the diagram. Of course, if the wagons were loaded up to full capacity, these percentages would be very much changed.

It is to this point especially that I wish to direct your attention, as upon it the economy of the 3-feet gauge rests. Whatever saving may be effected in first cost may be lost sight of, the great advantage lying in the saving effected in working expenses. *Every ton of dead weight saved goes toward securing the prosperity of the line,* and if we can obtain the ample platform which the 3-feet gauge gives, combined with so much saving in weight, there is nothing left to be desired. In making my comparison, I have taken matters as they exist in Queensland and in Norway. The able engineers of those lines have designed their stock as economically as they found possible. I should have thought the dead weight might have been reduced to a certain degree; but of course I am aware that no such reduction as may be made on a 3-feet gauge could be achieved.

Before I conclude, I may refer to one or two prevailing errors which exist with regard to the narrow gauge, and which are often urged against it. It is said that with a 3-feet or 3-feet 6-inch gauge, a far larger amount of siding and goods shed accommodation is required. Is it not sufficient to point out, as the wagons carrying the same amount on the latter as on a wide gauge are but some 10 feet long as compared to 16 feet, that a train of the former, conveying the same loads as on the latter, *would have but five eighths of its length?* Here, again, the axiom of subdivision of traffic is applicable in all its force.

Again, a common notion—and one that was strongly urged when the discussion concerning India was in progress—is that narrow-gauge railways may be constructed in difficult and hilly countries, but not on level and favorable ground. Doubtless this idea has grown from the fact that the saving of construction in the former localities is greater than in the latter But, as I have already stated, the economy in the cost of construction is altogether subordinate to the greater and constant economy in daily use. The fact is that narrow-gauge lines are useful everywhere, are needed everywhere; the saving in their first cost rises and falls with the country over which they pass, and, always considerable, is greatest where precipitous districts demand lines that creep around and up hill-sides; but the subsequent economy is not variable; it is always what I have shown it to be, when narrow-gauge railways and their equipments are worked, as everything should be worked, with a view to progress and development.



Diagrams Showing Proportions of Dead Weight to Paying Load in Railway Rolling Stock.

EXPLANATION OF THE DIAGRAMS.

The diagrams represent various proportions between dead weight and paying load, on railway rolling-stock, as follows:

A shows the average load carried in daily practice by the Fairlie engine, "Little Wonder," over the Festiniog Railway, 1-foot 11½-inch gauge, the average upgrade being 1 in 92. The engine weighs 19½ tons, the weight of load is over 107 tons, and the proportion of paying to non-paying load is 3 to 1.

B shows the average daily working of the ordinary engine, weighing 10 tons. The load carried is a little in excess of 43 tons.

[The above diagrams show very clearly the capacities of the Festiniog Railway after and before the adoption of the Fairlie engines on it.]

C shows the maximum load of 120 tons carried by the most powerful engines on the 3-feet 6-inch Norwegian Railway up gradients of 1 in 90. The proportion of paying to dead weight is 1.6 to 1.

D represents the daily working of the freight train on the Imperial (Russian) Livny Railway, 3-feet 6-inch gauge, up gradients of 1 in 80. The gross load conveyed (exclusive of engine) is 354 tons, of which 260 tons are paying weight. The engine weighs 42 tons, and the proportion of paying and non-paying loads is 2.78 to 1.

E represents the actual ratio between dead and paying loads conveyed in a 250-ton goods train on the 4-feet 8½-inch gauge; the lighter tint indicating the maximum capacity of the stock, giving 1.8 to 1 of paying to dead weight.

F shows the weight of a train on the 3-feet gauge carrying the same paying load, 50 tons, as that conveyed by the wagons on the 4-feet 8½-inch gauge, as shown in the previous diagram.

G is a diagrams showing the existing ratio between dead and paying weight on passengers' train, 4-feet 8½-inch gauge, as well as its maximum capacity, being 30 to 1 and 3.3 to 1, respectively.

J I H are diagram showing the comparative dead weights of trains onthe 4-feet 8½-inch, 3-feet 6-inch, and 3-feet gauges, respectively, employed to carry 50 tons of paying load, every wagon of each train being loaded up to the present average weight of 1 ton per wagon.

*The stock here described is on the type used in this country; a different type would require to be made to suit different tastes, as in America, for instance, carriages should have a central passage and rest on two bogies or trucks, with entrances at each end.

—The sixth annual session of the Grand Lodge of Locomotive Firemen commenced in St. Louis on the 21st inst. Delegates were present from New York, New Jersey, Pennsylvania, Ohio, Massachusetts, Vermont, Connecticut, Virginia, Indiana, Michigan, Illinois, Wisconsin, Iowa, Missouri, Kansas, Nebraska, California, Minnesota, New Hampshire, and Canada. An address was delivered by Henry Toppman, Grand Master.

RAILROAD GAZETTE

PUBLISHED EVERY SATURDAY.

CONTENTS.

	Page.
ILLUSTRATIONS.	
Welch's Car Truck	295
Proportions of Dead Weight	297
Indicator Diagrams	301
Feed-Water Heater	304
EDITORIALS.	
"Railway Gauges"	298
Myers' Pneumatic Car	298
The European & North American Railroad	299
A Road Masters' Convention	299
The Gazette and the Master Mechanics' Association	299
General Ticket Agents' Association	299
EDITORIALS.	
Among the Shops	299
GENERAL RAILROAD NEWS.	
Missouri River, Fort Scott & Gulf Railroad Report	300
Elections and Appointments	302
Old and New Roads	302
Mechanics and Engineering	304
SELECTIONS.	
Railway Gauges	295
Bauschinger's Indicator Experiments on Locomotives	301
Tree-Planting by Western Railroad Companies	304

Editorial Announcements.

Correspondence.—We cordially invite the co-operation of the Railroad Public in affording us the material for a thorough and worthy Railroad paper. Railroad news, annual reports, notices of appointments, resignations, etc., and information concerning improvements will be gratefully received. We make it our business to inform the public concerning the progress of new lines, and are always glad to receive news of them.

Inventions.—Those who wish to make their inventions known to railroad men can have them fully described in the RAILROAD GAZETTE, *if not previously published,* FREE OF CHARGE. *They are invited to send us drawings or models and specifications. When engravings are necessary, the inventor is expected to furnish his own engravings, or to pay for them.*

Engineering and Mechanics.—Mr. M N. Forney, Mechanical Engineer, whose office is at Room 7, No. 72 Broadway, New York, has been engaged as Associate Editor of this journal in charge of these departments. He is also authorized to act as our agent.

Articles.—We desire articles relating to railroads, and, if acceptable, will pay liberally for them. Articles concerning railroad management, engineering, rolling stock and machinery, by men practically acquainted with these subjects, are especially desired.

☞ *Our Prospectus and Business Notices will be found on the last page.*

"RAILWAY GAUGES."

On another page we republish Mr. Fairlie's paper on this subject read before the last meeting of the British Association. He reiterates much that he has said before; but unless his followers in this country make a new departure, they will be left behind his latest most advanced position, which is, that "without his loco-"motive the value of the narrow-gauge at once sinks "into insignificance." If, for the sake of the argument, we should grant all that he so modestly claims for the locomotive which he has christened with his own name, then it must either have advantages on the narrow gauge which it has not on one of 4-feet 8½-inch, or else with it the latter gauge is as good as the former.

Suppose we state this algebraically. We will let the advantages of the Fairlie engine on the narrow gauge be represented by x and on the wide gauge by y. The value of the narrow gauge, independent of the double-bogie engine, we will represent by a, and of the wide gauge by b. Now if the value of the narrow gauge without the engine referred to "sinks into comparative "insignificance," then $a = b$. If, as Mr. Fairlie has heretofore stated, the advantages of his engine are not confined to "his" (?) gauge, then $x = y$, therefore

$$a + x = b + y,$$

or, in other words, the wide gauge under the same circumstances is as good as the narrow.

Mr. Fairlie also repeats the statement of the monstrous disproportion of 7 to 1 of the dead to paying weight of *freight cars* on the London & Northwestern Railway. If we admit that such is the fact, we are still forced into the dilemma, that either he knows that the working of this road is not a fair example of railroad practice, or, if he does not, that he is ignorant of some facts with which he should be acquainted before he can discuss the subject intelligently. The proportion of dead to paying weight on American railroads, as we have repeatedly shown, is only about 1¼ to 1—we are speaking of freight traffic only. If the freight cars of the London & Northwestern have a carrying capacity of 1¼ times their weight, then they must run, on an average, loaded to only about one-tenth of their capacity. We are told that on the Imperial Russian Livny Railway the proportion of dead to paying weight is as 1 to 2.8. In a recent letter from the office of the Fairlie Engine Company, we are told *incidentally* that "it should be added the trucks on that "(Livny) line always carry full loads." In other words, Mr. Fairlie takes the dead weight hauled on a road on which the cars are loaded to only one-tenth their carrying capacity and compares it with that carried on a road where "the trucks always carry full "loads," and therefrom he proves that the dead weight carried on 4-feet 8½-inch-gauge roads is eleven times what it is on "my system." Could any comparison be more unfair or conclusion more absurd?

He announces as "a most important fact," that in England "the average load of merchandise carried by "each wagon is considerably less than one ton." If this is true, it seems to us there must be some good openings there for quite a number of first-class American railroad superintendents and freight agents. Mr. Fairlie's cure for the evil is smaller cars; but what reason is there for believing that if the size of cars were reduced the average loads might not be considerably less than 100 pounds instead of a ton? If the evil is as great as is represented, and can be cured by the use of small cars, what is there to prevent their use on ordinary roads?

The statements about the reduction of dead weight due to the narrowness of the gauge are reiterated, and we regret to say that, owing to the frequency with which they have been repeated, they have come to be accepted by a great many people without question. In explanation of the advantages inseparable from the "Fairlie gauge" (!) he says: "The principal of these "are: the reduced widths between the sole-bars for the "wider frames of wagons and carriages, and lengths "of wheel centers; these, in turn, affect the scantlings "of material, the weight of the wheels, the size of "axles, to carry certain loads." Now we are not quite sure that we know what he means by "sole-bars," as the term is never used in this country. If it means the timbers to which what we call the pedestals are fastened, then we are at a loss to know how reducing the width between them will affect "the scantlings of "material." If the sole-plates are what we here call the outside sills, then their distance apart is governed by the width of the car body, which is, within certain limits, independent of the gauge. In fact, we do not know of any timbers or bars on *the car body* whose distance apart would be affected by the gauge, which would, from that cause, have any influence upon the weight of the car, and, even if it were so, it would not hold good of double-truck or "bogie" cars.

That the distance between the wheel centers is reduced by narrowing the gauge is also an assumption not borne out by facts, as is shown by our car-trucks, some of which are running with the wheels as close together as they can be placed without touching. That the size and weight of axles and truck-frames is increased by widening the gauge is of course true, but no such reduction as that claimed by the narrow-gauge advocates for their cars, can be attributed to this source. We are also unable to understand how the weight of the wheels would be influenced by the gauge.

We do not find the question answered in Mr. Fairlie's paper, nor in any other narrow-gauge literature, *why* cars of a similar kind can be made so much lighter for the one gauge than for the other. If they can be, there must be some good reason for it. What is it? Our columns are open to explain it at any time. We know of the twaddle which has been spoken about a beam being stronger with the supports near together than with them far apart, but every man with any practical experience of what is required in cars knows that such a vague theory is all nonsense. A car is not a beam, nor are the strains to which it is subjected due to statical weight, but to shocks and jolts which are very dynamic indeed, as anyone can convince himself who will stand at the side of a rough railroad track when a train passes at a speed of 15 or 20 miles per hour, or will watch a careless locomotive runner start a train in a difficult place.

To talk about the distance between "sole-plates" and wheel-centers may appeal to the ignorance and prejudice of people, and may possibly be used with much effect by parties interested in getting appropriations and contracts, but something which has more of common sense in it must be used with practical car-builders or railroad mechanics before they will be convinced.

There is now an immense amount of writing done in this country on narrow gauge by interested parties, who have, many of them, very dull axes to grind. Engineers without any practice or business see in the popular excitement that there is an opportunity to further the "main chance." Contractors in search of a paying job, and schemers of all kinds who have anything to sell which a narrow-gauge railroad company might buy, all join in the clamor and repeat the fallacies and misstatements in every conceivable form. Of course there are men who are entirely honest in their convictions and intentions, but many of them have been misled by the popular clamor.

The animus of it was well illustrated not a great while ago by a remark made by a person with whom the writer had a discussion on the merits of the new system. We discussed the whole question very thoroughly and we were inclined to believe that the faith in the narrow gauge of the old gentleman to whom we were talking was a little weakened thereby, as he ended it by saying that "*any way*, we would find that "people could be induced to invest money in narrow-"gauge roads who would not put it into broad."

On another occasion, in attempting to explain the relative merits of the wide and narrow gauges to a dealer in rails, he replied, "D—n the narrow gauge! What "I am after is to sell rails."

We have before us a slip cut from a paper published in a county in Missouri where parties are endeavoring to get appropriations for a narrow-gauge road. It says: "Each county which has a narrow-"gauge road may have a voice in its control after the "road is finished. This is one of the advantages of the "new style gauge. They can be built for fifty per cent. "less than the old style, and then be owned and con-"trolled by the counties." If the writer had added that it would cure corns, remove bunions, and was good for the liver, perhaps people would not have believed him; but there would have been very little less nonsense in the last statement than in the first.

MYERS' PNEUMATIC CAR.

A trial of this invention was made at Hyde Park, near Chicago, last Saturday, in the presence of about forty invited guests. The pneumatic car is in fact a locomotive engine driven by compressed air, contained in a large cylindrical tank mounted on four wheels, similar to those used on an ordinary horse car. The main tank is 7 feet in diameter and 16 feet long, made of boiler plate. Underneath this tank and between the two axles are a pair of ordinary cylinders and pistons which drive an intermediate shaft which gears into a wheel on one of the axles. At each end of the car, or engine, and under the main tank, are two smaller reservoirs 15 inches in diameter, both connected with the larger one. One of these smaller reservoirs has what is called a governor or regulator between it and the large tank. This consists of a very ingeniously-arranged valve, which will admit air into the smaller reservoir until the pressure in the latter reaches any point determined upon, but considerably less than that in the main tank. For example, if the pressure in the large reservoir is 130 pounds per square inch, the regulator may be graduated so that as soon as the pressure in the small or supplementary reservoir reaches 30 pounds, the regulator will close. We could not describe this arrangement so as to be understood without an engraving. The cylinders draw their supply of compressed air, with which they are driven, from the smaller reservoir, and the object which it and the regulator are intended to accomplish is to keep the pressure of the air supplied to the cylinders uniform. Supposing, for example, that the air is exhausted from the main tank until its pressure is reduced to, say, 50 pounds. Without the regulator the cylinders would be supplied with air of 130 pounds pressure at the start, which would gradually be reduced as the supply was exhausted. The regulator, however, will not admit any more air into the small reservoir than will produce a pressure of 30 pounds per square inch in the latter. By this means a uniform pressure is maintained to supply the cylinders. There is also another object attained by this arrangement.

If the valves of an engine of this kind are reversed while running, the pistons will act as pumps and force air back into the reservoir. If the pressure in the latter were at its maximum, it would be difficult to force air into it, but if the pressure did not exceed 30 pounds per square inch it would be comparatively easy. In stopping the car or train the valves are reversed, and its momentum is utilized to force air back again into the small tank. By this means not only is power economized, but the pressure in that which supplies the cylinders is increased above the ordinary working pressure, and is available in starting the car.

The other small tank to which we have referred has a check-valve between it and the large tank. The object is to keep a small supply of air at the initial pressure, so that in case of emergency, such as getting off the track or other accident, there may be power enough to overcome the difficulty. The two small reservoirs are connected together with a pipe, having a cock or valve between them, so that the air contained in the one may be admitted into the other.

It will thus be seen that the arrangements and provisions for operating with compressed air have been made with much care and the whole scheme looks quite promising.

The supply of air is of course compressed by a stationary engine and pump. The arrangement used at present is an ordinary portable engine, with a pump worked by a crank.

The advantages which are claimed for this system—which is especially intended for operating railroads on which horse power is now used—are that pneumatic power can be used on streets with less noise, without smoke and danger of explosions; that a pneumatic engine can be operated by a person with much less skill than is necessary in working a steam engine. There is, of course, a loss of power in compressing air due to friction, etc., but on the other hand it is claimed that one large stationary engine will work much more economically than many small locomotives. It is also thought that the waste due to the loss in compressing the air will be more than compensated for in the saving of wear and tear, repairs, etc., of locomotive boilers.

A public exhibition of the kind made on Saturday affords but little opportunity for applying any severe tests, or of making any conclusive experiments; but although we went to it with some reluctance and with little expectation of finding anything of real value, we were obliged to revise our preconceptions and change our opinions.

The machinery of both the locomotive and stationary engines will admit of much improvement, and the former can probably be very much reduced in weight. It now weighs 12,000 lbs., which is very much heavier than is necessary.

We are promised drawings of the locomotive engine as soon as some changes on it are made.

The European & North American Railroad.

The last rail was laid on this road on the 20th inst., and there is now an unbroken railroad route from St. John, New Brunswick, to San Francisco, and the route is nearly completed as far east as Halifax. The distance from Bangor to St. John is just about 200 miles, and this is what forms the European & North American Railroad. St. John is 338 miles by rail from Portland, 445 miles from Boston, and 677 miles from New York (less by sea), and is nearly in the route of ocean steamers between New York and Liverpool, so that by starting or landing at St. John, the ocean voyage may be made nearly two days shorter. Vessels, however, do not usually stop at St. John, but do stop at Halifax, which will be 256 miles by rail from St. John, and, therefore, 933 miles from New York. It is, however, only about 650 miles from New York by sea. It is believed by those who undertook the European & North American road that the shortening of the sea voyage by two days or more will draw a large, if not the largest, part of the travel between Europe and North America to the port of Halifax and over their railroad. With all the roads in perfect order, probably a saving of 24 hours can be made by this route over that by New York, and doubtless this saving will have its effect. It is doubtful, however, whether those who go to or come from places much further west than New York will care to lengthen the rail route, which from San Francisco to Halifax would require about nine days, and, doubtless, pretty thoroughly tire out the passenger who should make the trip. It is probable, also, that the steamers will make their fares to Halifax pretty nearly or quite as high as to New York, since they must go to the latter port, and to go empty will be very nearly as costly as to carry full cabins. In this case immigrants would very rarely take the Halifax route unless they were destined for points east of Boston.

The new line will give close connections between the maritime provinces of the Dominion and the United States, between which relations have almost always been intimate, and which now should become more intimate and mutually profitable.

A Roadmasters' Convention.

Mr. John Hargreaves, Roadmaster of the Buffalo, New York & Philadelphia Railroad, writes to us from East Aurora, N. Y., suggesting that a convention of roadmasters might be productive of great good, and, in view of the near approach of the time of year when these important officers are engaged in very difficult and constant work, that such a convention should be held soon.

Doubtless the discussion of the various practices of roadmasters in maintaining road and road-bed in different sections of the country, and under varying circumstances, would be instructive to the roadmasters and advantageous to the companies. Any roadmasters who favor Mr. Hargreaves' suggestion would probably do something towards securing an organization and a meeting by writing to that gentleman, to the address above mentioned. We will gladly publish any call which they may see fit to make.

The Gazette and the Master Mechanics' Association.

We have not yet received copies of the minutes and reports of the late convention of master mechanics, but the Secretary of the Association has promised to furnish them within a few days, and as soon as received we will commence their publication in the GAZETTE in full. The adoption of the RAILROAD GAZETTE by the Association as the medium for the publication of all its notices and announcements will add to the interest of our columns, and make the paper of more value to railroad men generally.

The General Ticket Agents' Association.

This association commenced its semi-annual meeting in Philadelphia on the 27th inst. It has been decided to hold the annual session next April in San Francisco.

AMONG THE SHOPS.

A person who has not visited the shops of the LOUISVILLE & NASHVILLE RAILROAD since they have been under the management of Mr. Thatcher Perkins will see that a very marked change has been brought about by him. In former times everything about them seemed to be at very loose ends, and a general dilapidated and careless look pervaded the whole establishment. Strangers were very apt to impute this to influences peculiar to the latitude; and railroad men whose lines had fallen nearer to the North Pole were prone to shrug their shoulders and feel thankful that they were not as other men are, and their management not so bad as that which controlled the Louisville & Nashville shops. Such persons, if they were to visit the same place now, would be obliged to amend their uncharitable verdict, and concede that such a thing as a well-managed shop does exist south of the Ohio River.

To a person who cherishes the best wishes and entertains the most kindly feelings, and earnestly desires to see the South increase in prosperity, this fact is a great encouragement; because, if a railroad shop can be well managed, why may not other manufacturing and engineering enterprises be equally successful? and if, in building locomotives, Louisville can rival Philadelphia and Paterson, it shows that in other enterprises the South may also become a competitor of the North. We are very apt to fall into the habit of thinking that nearly all manufacturing enterprise is confined to colder climates, and that the mechanical instinct does not thrive under a warm sun. It is therefore a very useful lesson when it is found that only the industry and energy of such a man as Mr. Perkins is necessary to carry what might be called the "industrial isothermal" lines southward.

Since Mr. Perkins' administration, not only have the old shops been much improved, but they have to a very great extent been equipped with new tools, and extensive additions have been made to the old buildings. Since we first visited this place a street has been cut through from Broadway, west of the passenger and freight houses, and extending parallel with the railroad track beyond the shops. The company own all the ground between this street and the railroad track, and also own a large lot of about 12 acres on the opposite side of the new street for their car works. These new shops have been equipped with the latest and most improved wood-working machinery of every description. The two main buildings which have thus far been put up are one for the wood-working machinery and another for the erection of cars. The former is 75x200 feet and two stories high. It has one of the engines of the Putnam Machine Company, which supplies power to the whole building. These engines are not surpassed for smoothness and economy of working. The engine-room is very neatly and tastefully fitted up, and all kept in the most perfect order.

It is hardly necessary to describe the machinery in these shops, as it does not differ essentially from that of others which have the best character of equipment. Our attention was, however, especially called to a saw-grinding machine, which, although not new, is one whose operation we had never seen before. The saw—either circular or straight—is held in position with suitable attachments, so that it can be moved in such a way as to bring each tooth successively to the edge of a beveled emery-wheel, which, of course, revolves at a suitable speed. Each tooth is thus ground to a sharp point and edge with surprising quickness and accuracy. The attachments for moving the saw are very ingenious, and quite easily handled.

The roofs of the two principal buildings of the car department are very good specimens of skillful roof-building, and were designed by Mr. Fink, the Chief Engineer of this road. We will try to give an engraving of them in some future number.

The company is now building 11 first-class passenger cars, of which six are finished. They are 46 feet long, 10 feet 4 inches wide, and seat 48 passengers, have saloons, wash rooms and a stove at each end, and are supplied with Carroll's ventilators in the raised roof. We regret not being able to give the weight of these cars, so as to be able to compare it with that of those of a similar character which are usually made longer.

The freight-car truck used by Mr. Perkins is similar to that built by the Baltimore & Ohio Railroad Company, and is made almost entirely of wood. It has one very important merit—that of cheapness. It is said to work very satisfactorily, however, and the only trouble we heard of in regard to it was the difficulty of getting thoroughly seasoned timber for its construction.

The machine shops have received large additions of machinery, built chiefly by Bement, but some few pieces we noticed were made by the Fitchburg Company. The order and arrangements in the shops were very perfect, and a new tool-room is one of the evidences that things are not left to take care of themselves. This room was supplied with most of the requisites for such work, among which must be ranked first, a capable man to take charge of it. The machines in it are a lathe, Brown & Sharpe universal milling machine, and an emery-wheel. The latter was lacking in an attachment for trueing up work, such as taps, drills, crank-pins, etc., after they have been hardened. Persons who have given no attention to this will be surprised to find how much all kinds of work will be sprung in tempering or case-hardening, even by the most careful workmen.

In another part of the shop Mr. Perkins has fitted up a grinding-room for finishing ordinary work on grindstones and emery-wheels. If good workmen can be procured, this is the best and most expeditious way of doing much of the "bright work" on a locomotive. The difficulty of getting good men is due, to a very great extent, to the exceedingly unhealthy character of the employment. And here we feel bound to find fault and make complaint in behalf of the men employed in this room. There is no provision for exhausting the air and the dust from either the grindstones or emery-wheels. An arrangement for doing this would cost very little, and would be as sure to extend human life as would be the drawing of a ball-cartridge from a musket before being fired at a man's head. The breathing of the dust in such a room is surely, although slowly, fatal, and no company or individual is justified in omitting to provide any appliance which will either obviate or mitigate the evil. Our advice to all men so employed is to draw up a respectful petition setting forth the injurious effects of inhaling the dust from the work done in this way, and we have faith enough in the humanity of railroad officers to believe that in nearly all cases the evil would be remedied.

All the shops over which Mr. Perkins has control are made so comfortable for his men that we think all that is needed is to have his attention drawn in this direction to immediately have provision made for the health of his employes.

In this connection we desire again to call attention to the importance of making men comfortable, if the best service is expected of them. A wash-room for mechanics, a reading and sleeping-room for locomotive runners, or shelter for men who do car-repairs or other out-door work, will, in the first place, make them much happier men and more healthful and contented, and will amply repay, in the better service rendered, for all expense incurred in this way.

It is said that the character of a hotel is always indicated by the condition of the mustard cruets. If we were called upon to give a similar criterion for estimating the management of a machine shop, we should refer the enquirer to the drawing-room. It is not often that a shop is carelessly managed which employs a good draughtsman, and has an orderly, clean and well-lighted drawing-room. If, on entering this department of any machine shop, everything is found in its place, and the drawings carefully and neatly made, there is not much risk in inferring that the rest of the establishment is well managed, and that things are properly "looked after." Both the drawing-rooms and the shops of the Louisville & Nashville Railroad verify this observation. The former is large, airy, clean and well lighted. Two good draughtsmen are employed in it, and it is very seldom that such good specimens of their art will be found anywhere as adorn its walls. The drawings are kept in drawers, properly assorted, and when anything is wanted there is no bustle or hurry or confusion in looking for it, but either of the draughtsmen can put his hand on it at once. This room might be termed the cranium of the establishment, as it is here that much of the thinking is done and is put into a concrete form. But, after going through all the shops and the drawing-room, the source of the good management will still be found to originate from its superintendent, and is the result of his knowledge, energy, experience and ingenuity. The engines which he has just completed will perhaps be the best evidence of the ability of their designer. The workmanship on them is equal to any we have ever seen, and their design very good, although perhaps involving some work more expensive than that which builders of locomotives could put on engines at prices which they are getting at present.

Mr. Perkins has just completed a new passenger engine designed for the heavy trains and grades of their road and traffic. It has been much admired and commented upon by the master mechanics during the recent session of their convention. Some one was rash enough to write a piece of poetry about it and have it set to music. There is more to admire, however, in the engine than the poetry.

It—the engine—(we might also say the poetry) is of the ordinary American type. It has 18x24-inch cylinders and 66-inch driving-wheels, and weighs 71,000 pounds in working condition. The boiler is 50 inches in diameter, with a wagon-top of 7 inches rise, and has one dome 28 inches in diameter, located over the fire-box. The latter is 73 inches long, 68 inches deep, by 37 inches wide, and the boiler has 172 2-inch iron

tubes 11 feet 8¼ inches long. The crown-sheet is stayed with fifteen double transverse crown-bars. These are formed of two bars, with a brass lug between them at each end, which rest on the edge of the side-sheets. On top of the crown-bars and on the inside of the wagon-top shell are riveted two pieces of angle iron, which are connected by iron braces. The ends of the boiler have double sheets and angle iron attached, which latter are connected to the shell of the boiler by braces.

The boiler is double-riveted in all its seams, with rivets ⅝ inch in diameter, 1¾ inches from the centers of those in one row to the center of the adjoining rivet in the other row—the rows being 1 inch apart. The boiler shell is made of ⅝-inch iron, fire-sheet of 9-16-inch copper, and the fire-box of steel ⅜ inch thick. The bolts in the crown-bars have rivets underneath. The fire-box has hollow stay-bolts on the sides, with 3½ inches water space.

The engine has the ordinary shifting link hung from below. The throw of the eccentrics is 5¼ inches, and the valve has ⅞ inch outside lap. The steam-ports are 1¼ inches by 17, exhaust port 2½ inches wide.

The driving-wheels are spread 100 inches from center to center, the total wheel-base being 22 feet. The truck-wheels are 26 inches in diameter, and spread 66 inches.

The guides, piston-rods, etc., are made of steel. The coupling-rods have solid brass bushings, which are attached to the crank-pins or journals, 5 inches in diameter by 4 inches long.

The cab is made of ash, with walnut moldings, and the engine is finished all over with considerable ornament.

Mr. Perkins is also building four 10-wheeled engines, two of which are just completed. Their cylinders are the same size as those in the passenger engine—18x24 inches—but the driving-wheels on the 10-wheeled engines are only 53 inches in diameter. The boilers are similar to that already described, excepting in the length of the tubes; those for the 10-wheeled engines being longer than the others.

One pair of driving-wheels is located behind the fire-box, and the main pair immediately in front. The distance from the center of the rear or trailing wheels to that of the main wheels is 91 inches, and from the center of the latter to that of the front pair of driving-wheels, 75 inches., and from their center to that of the truck, 77 inches. The spread of truck-wheels is 66 inches, so that the total wheel-base of the engines is 23 feet.

The frames of both the engines we have described are forged solid, and are fitted into a socket in the cylinder casting and fastened with keys, no bolts being employed to bolt it fast. The original material is thus preserved, and the frame not weakened by drilling away for bolt-holes. The frames are made in two pieces, and spliced in front of the front jaws.

The cylinders are horizontal, and cast so as to be attached together in the center of the engine. The cross-heads are made of wrought iron, and as there is not room enough in engines of this plan to use the ordinary double guides, and as a single one gives too little bearing surface, two guides, one above the other, are used, and the cross-head arranged so as to have a bearing on each. We have been promised a drawing of this, and will furnish our readers an engraving as soon as received.

The pumps are worked from a crank on the back pin; and have 7-inch stroke, and a plunger 4 inches in diameter. Each engine has two pumps and an injector.

The smoke-stacks are straight, with Smith's patent spark arrester, which, we regret to say, has not worked with entire satisfaction. Our regret is because this invention promised to enable us to dispense with the hideously ugly smoke-stack which is so generally used on American engines. Mr. Perkins is, however, still experimenting with this invention, and if he should make it work to his satifaction we will endeavor to give a report of its performance.

The height of these engines from the top of rail to center of boiler is 70 inches.

The coupling-rods have solid bushings on the center crank-pins, and stub-ends on the front and back pins. They also have a kunckle joint immediately behind the middle pin.

We have omitted to state that the front tires have no flanges. This is requisite on account of the sharp curves on the road.

These engines are, we believe, the first that have been built south of the Ohio or Potomac rivers since the war, and, as specimens of mechanical engineering and workmanship, will compare favorably with any built elsewhere. We trust that the area of similar industrial enterprise may be extended over a larger extent of the Southern territory.

THE LOUISVILLE BRIDGE & IRON COMPANY.

Quite near to the shops of the Louisville & Nashville Railroad are the works of the Bridge Company; and after seeing the locomotives which we have described, and then examining the magnificent bridge over the Ohio River which this company has lately completed, we are disposed to make the generalization that the Southern mind is better fitted to grasp that which is great and large, than to conduct the minute details required in manufacturing smaller articles. If we were disposed to speculate over this, we could cite a variety of facts to sustain our position. We will not say that such a characteristic is entirely good nor altogether bad; but it is a peculiarity of the Southern character, which, while it may gain something in one direction, loses perhaps much more in another.

The Louisville Bridge & Iron Company at present occupies shops which they expect soon to vacate. They have just broken ground and commenced work on new buildings south of the car shops of the Louisville & Nashville Railroad. Their present buildings are of a rather temporary character, although affording facilities for doing a large amount of work. About one hundred and fifty men are employed in these works, and two gangs are engaged in the erection of bridges in different places. For work of this kind not a very large equipment of machinery is required—a few lathes, drill presses, etc., being sufficient for doing all the finished work used on the bridges built by them. For testing the bars before erection, they have a very good hydraulic machine. The ram is 9 inches in diameter, and capable of subjecting a bar to a tensile strain of 500,000 pounds. All bars are subjected to a test of 20,000 pounds per square inch. The extension of each one due to such a strain is carefully noted, and also the contraction after the strain is relieved. If the bar does not recover its original length, it is condemned. The failures are comparatively few in the whole number of bars tested.

This company are now making many of their heavy braces of two small I beams riveted to the web of a larger one of similar section. This gives the requisite lateral stiffness, and the whole is accessible for painting—an important point in iron bridge construction. Smaller braces, and those subject to strains of both compression and tension, are made of flat bars with zig-zag bracing between.

The plan of bridge which has been chiefly adopted by this establishment is the Fink suspension and the triangular truss. The latter is similar to what is known as the Warren girder in Europe. The largest single work ever done by this company is the Louisville Bridge over the Ohio River, of which we expect soon to give a lithograph showing it in detail.

They have the following work now in progress:

For the Elizabethtown & Paducah Railroad—4 spans of 75 feet; 3 spans of 100 feet; 1 span of 146 feet; 6 spans of 174 feet; 5 spans of 200 feet; 3 draws of 284 feet; 1 span of 216 feet. The draws are built of wrought iron. The other spans are a combination of wood and wrought iron.

For the Owensboro & Russellville Railroad—1 draw of 284 feet; 3 spans of combination bridge, 125 feet each; and several others of 100 feet span and less.

For the Nashville & Chattanooga Railroad—21 spans averaging about 150 feet span; the latter are made of all wrought iron.

For the Nashville & Decatur Railroad—6 spans of combination bridge averaging about 150 feet span.

For the South & North Alabama Railroad—About 3,000 feet of bridging.

For the Mobile & Montgomery Railroad—The Tensas Bridge of 12 spans, combination bridge, 150 feet each; 1 span, and 1 wrought-iron draw, 260 feet.

For the Memphis & Charleston Railroad—4 spans combination bridge, 1 wrought-iron draw, 160 feet.

For the Memphis, Clarksville & Louisville Railroad—1 span combination bridge, 200 feet; 2 spans combination bridge, 125 feet.

Besides the above they have quite a number of other bridges of smaller spans.

These works are another evidence of the enterprise of Louisville, and the fact that manufacturing can and is done on a large scale at the South as well as at the North.

THE LOUISVILLE CAR WHEEL AND RAILWAY SUPPLY COMPANY.

While in Louisville, we also visited this new establishment, which has just been started and quite recently commenced operations. The company has just erected a very neat foundry 80x100 feet, which, when entirely completed, will have capacity for making 80 wheels per day. It will have five swing-cranes, and it is expected that two men will mold 16 wheels on each crane.

The officers of this company are Dr. E. D. Standiford, President; John E. Green, Secretary and Treasurer, and J. P. May, Superintendent. The latter has had extensive experience in the manufacture of car wheels, and we learn that the wheels made by him have proved unusually good and worn as well as the best. For convenience of reference we give the weights of the wheels they make:

33-inch	double-plate	passenger car	wheel	550 pounds
33 "	" "	freight "		525 "
31 "	" "	passenger "		465 "
28 "	" "	"		410 "
26 "	spoke wheel			450 "

Louisville, on account of its proximity to the Cumberland iron region of Tennessee, some of which iron we hear very highly recommended for car wheels, seems to have especially good facilities for this kind of manufacture. The new establishment has our best wishes for its success.

LOUISVILLE, LEXINGTON & CINCINNATI RAILROAD SHOPS.

This company has just erected new shops, which we regretted not being able to visit. They are not entirely complete yet, but as soon as they are we will hope to give a description of them.

Rockford Bridge.

The American Bridge Company have contracted to build a Post's patent diagonal iron truss roadway bridge over Rock River, for $49 50 per lineal foot. There are to be four spans—461 feet total length. Each span is to be 106 feet, 9 feet clear between abutments, 110 feet between centers of end posts. There are to be 8 panels, of 13 feet 9 inches each. The trusses are to be 20 feet 7½ inches high, and 20 feet apart, making the roadway 20 feet wide in the clear, and outside of the trusses are to be sidewalks 6 feet wide each. The bridge is to be proportioned to sustain, besides its own weight, a moving load of 1,800 pounds per lineal foot with a factor of safety of 5. The top chord is to be cast iron, 10x12 outside, varying in thickness of metal from ½ to ⅝. The bottom chord is to consist of rectangular wrought-iron eye-bars.

The Missouri River, Fort Scott & Gulf Railroad.

The following summary of the annual report of this company for the year 1870, we take from the Kansas City *Times*.

The railroad extends from Kansas City southward through the tier of counties in Kansas next to Missouri, to the Indian Territory, a distance of 160 miles, through a fertile country which has grown with astonishing rapidity since the railroad was begun. This immigration has given the railroad a very large business from the beginning:

The Kansas & Neosho Valley Railroad was incorporated under a general incorporation law of the State of Kansas, March 8th, 1865, and the company was organized by the election of eleven directors, August 28, 1865. The name was changed October 10, 1868, to that it bears at present—The Missouri River, Fort Scott & Gulf road.

Leaving Kansas City the road runs through the border tier of counties in Kansas, adjoining our State, and extends to the southern line of the former State, a distance of 161 miles from Kansas City. The section of country traversed is not only extraordinarily beautiful, but highly productive, comprising a rich agricultural belt of prairie, fringed with timber along the streams, and through its southern half is abundantly underlaid with beds of coal, from three to five feet in thickness, of such remarkable purity and value that they have already become the favorite fuel in the city. The country, though so recently settled, is already pretty well developed, and the tide of immigration continues to pour in in a ceaseless stream.

CHARACTER OF THE ROAD.

This road is thoroughly first-class. The track is laid with rails of 57 to 58 pounds weight per yard, of approved section, thoroughly fished at the joints, and laid on about 2,700 ties per mile, mainly of white and burr oak and black walnut. All the culverts and small water-ways are of stone. The truss bridges are all of Howe truss pattern, built of Chicago pine and proportioned to 1¼ tons per lineal foot of bridge. Station arrangements are simple and the depots neat and substantial. Commodious depot grounds, generally 1,500 feet long and 250 feet wide, have been provided at all stations. In this city 54 acres were purchased for depot and shop room, which has already tripled in value. At Fort Scott 25 acres were given by the city and citizens. At Baxter Springs 20 acres were received for depot purposes, in addition to other lands subscribed by the people.

ITS TERRITORY.

The location of the road is such as to enable it to secure most of the business of the border counties of both Kansas and Missouri, and a careful estimate of the country directly tributary to it, after deducting the territory drained by other lines, shows it to amount to about 4 000 square miles, or an average strip of 25 miles in width for its entire length. The business of this strip is mainly with our city, and probably no competition can alter it to any great extent.

PROGRESS OF BUILDING.

The first section of the road in the town of Olathe, 21 miles from this city, was opened for business on the 16th of December, 1868, and on the 9th of December, 1869, the city of Fort Scott was reached, a distance of 109 miles. On the 2d of May the road was completed to the south State line, and regular trains were running to Baxter Springs, the present terminus.

ITS ENDOWMENT

is as follows: In seven per cent. coupon bonds, with thirty years to run from date to maturity:

Of Kansas City	$200,000
Of Johnson County	100,000
Of Miami County	150,000
Of Bourbon County	150,000
Of Baxter Springs	150,000
Total of bonds	$750,000

The lands granted by the State of Kansas amount to 125,000 acres, and that actually obtained under the congressional grant, about 17,500 acres. The principal endowment, however, were the Cherokee neutral lands, which were obtained in the name of Mr. Joy, and subsequently conveyed by him to the company, and which have all been paid for and the patents obtained. By this purchase the company acquired 639,000 acres.

The aggregate sales of these lands to date, are 283,012 85-100 acres, at an aggregate price of $1,705,397.76, or $6 343 per acre.

COST OF THE ROAD.

Although the road was built in the best possible manner, the cost of construction was by no means enormous—being $6,651,690.57, which includes, however $801,973.73, expended for the purchase and management of the neutral lands.

ROLLING STOCK.

The equipment of the road consists of the following:

Manchester locomotives	21
Combination cars	250
Flat cars	80
Coal cars	125
Way cars	6
Baggage cars	1
Mail and express cars	2
Smoking cars	2
Coaches	10
Accomodation cars	2
Sleeping cars	3

BUSINESS OF THE ROAD.

The total earnings of the road for the year of 1870—the road being completed to its present terminus eight months of the time, were $1,199,220.58; the operating expenses, $457,222.18; leaving a net balance of $741,998.40.

The travel over the road for the year ending December 31, 1870, is as follows:

Number of through passengers South	2,736
Number of way passengers South	64,444
Number of through passengers North	2,080
Number of way passengers North	53,080
Total passengers carried	122,290

During the year there was carried over the road 2,102 cars of coal, 765 cars of grain, and 3,052 cars or 62,232 head of live stock, from which the following are the earnings:

From coal	$48,567 30
From grain	24,866 95
From live stock	113,598 00
Total from the three sources	$186,962 25

In December the largest amount of coal was carried, being 625 cars. The same month the largest amount of grain was carried—102 cars—and November was the largest in live stock—948 cars, or 19,456 head having been carried.

The proportion of operating expenses to the earnings, including taxes, is 38.12 per cent., and not including taxes, 36.63 per cent.

Bauschinger's Indicator Experiments on Locomotives.

(Continued from page 289.)

(*d*) *Expansion.*—The action that takes place in the cylinder during the period of expansion is of special importance for the purpose of comparing the various theories respecting the action of the steam in the engine. The essential differences of these theories consist solely in the application of several hypotheses respecting the relative pressures and volumes of saturated steam. The results of practice show, however, a marked discrepancy between the theoretical curves of expansion and the actual expansion line drawn by the indicator, and in order to investigate these circumstances, Professor Bauschinger has selected two curves taken from the hind cylinder end of engine (*A*). These diagrams, which are reproduced in figs. 23 and 24, are taken from the reversing lever in the first and fourth notches respectively; in one case the suppression of steam occurs, according to the distribution diagrams, at 14 per cent., and in the other case at 33 per cent. of the length of the stroke. In these diagrams the theoretical curves are laid down according to the laws of Redtenbacher, Mariotte, Rankine, and Zeuner, in the following manner:

1. Redtenbacher, agreeing with Pambour as to form, calculates the pressures of steam corresponding to different relative volumes, or the ratio between the volume (V) and (V_o) and the pressure (p) and (p_o) of expanding steam, by the formula $p = \frac{V}{V_o}(0.284+p_o)-0.284$, where p and p_o are expressed in atmospheres of 14.706 pound to the square inch. The expan ion line, obtained by this theory, is drawn in the diagrams (figs. 23 and 24) by a dotted line (– – – – p).

2. According to the laws of Mariotte, the pressures are inversely as the volumes, or $\frac{p}{p_o} = \frac{V_o}{V}$. The curve constructed after this formula is shown in the diagrams by a continuous line (———— M).

3. Rankine assumes that the expanding steam receives from the cylinder a certain amount of heat, sufficient to maintain its saturated state. The resultant curve has been calculated by the aid of Zeuner's tables of the properties of saturated steam, and is shown in the diagrams thus (– – – – – R). In fig. 23 this line coincides with the dotted expansion curve.

4. The theory of mechanical heat, established by Zeuner, is based on the hypothesis that the expansion of the steam takes place without loss or gain of heat from any external source, or $\frac{V}{V_o} = \frac{uX+q}{u_oX_o+q}$, where u and u_o = the specific volumes of the expanding steam, q = the specific volume of the water, and X and X_o = the quantities of saturated steam contained in a unit of weight of the expanding steam. The lines marked (–o–o–o m) in the diagrams have been constructed under the supposition that the steam was in a perfectly saturated but not surcharged state at the beginning of the expansion, or $X_o = 1$. The other lines (+–+–+ – m), on the other hand, correspond to the case of the steam contained, in the case of fig. 23, 70 per cent. of water, and, in the other diagram, 40 per cent. of water.

As shown by the diagrams, the departure of the actual curve from the theoretical curve of expansion is very considerable, and much more than the deviation of the various theoretical curves amongst themselves. In stationary engines, also, the indicator bears witness to similar difference existing in a greater or less degree. In order to investigate the facts which we have just considered, Professor Bauschinger proceeded in the following manner: From a number of indicator curves, taken at different degrees of expansion, the mean absolute pressure behind the piston was first measured and then compared with the mean absolute pressure of admission, the expansive curve having been continued to the end of the stroke. The figures thus obtained are given in column *D* of table IV. According to the law of Mariotte, the same relation of pressure is calculated by the following formula:

$$\frac{l_1}{l} + 2.3026\,\frac{p_1}{l}\ \log.\ \frac{p}{p_1},$$

where l_1 = distance traveled by piston during the period of admission, and l = total length of stroke including clearance space. The results calculated by this law, which also shows a nearer approach to the actual performance than the other theories, are given in column *E* of Table IV., while column *F* of the same table contains a coefficient obtained by division of the two preceding columns. A comparison of the preceding pressures

TABLE IV.

A	B	C	D	E	F	G	H	I
Class of engine.....	Notch.....	Period of admission in per cent. of stroke.....	Ratio of mean pressure behind piston and mean pressure during admission, according to Mariotte, in per cent. of pressure at admission.....	Ratio of mean pressure behind piston and mean indicated pressure during admission, in per cent. of pressure at admission.....	Comparison of columns D and E. $\frac{D}{E}$	Ratio of mean effective pressure and indicated pressure during admission in per cent. of pressure at admission.....	Ratio of mean effective pressure and mean pressure during admission according to Mariotte in per cent. of pressure at admission.....	Comparison of columns G and H. $\frac{G}{H}$
A	1	16	60	50	1.20	29	19	1.53
	2	23	69	60	1.15	42	33	1.27
	3	33	77	69	1.12	50	42	1.19
	4	38	84	81	1.04	60	57	1.05
	5	47	87	86	1.01	64	63	1.02
	6	55	91	90	1.01	69	68	1.01
	7	61	93	92	1.01	73	73	1.01

will be of more practical value, and accordingly the mean effective pressures of the same indicator curves were measured and compared with the mean pressure of admission. These results are contained in column *G* of Table No. IV., and by subtracting them from those in column *D*, we obtain the mean pressure before the piston in per cent. of the average pressure of admission; this coefficient again subtracted from column *E*, gives the mean effective pressure according to Mariotte. Finally, column *I* of Table No. IV. compares the results of columns *G* and *H*, and, as will be noticed, the actual performance of the engine is considerably above that of the theoretical power, thus, with a period of admission of 16 per cent. of the stroke, the work exerted, as shown by the indicator, is over 50 per cent. above the law of Mariotte.*

Instead of comparing in this manner the expansion curves of all the eight engines, the following simpler proceeding was employed. In each indicator curve were marked, from the distribution diagram, the beginning of expansion and release; the absolute pressures corresponding to both were then measured, and their relative ratio ascertained. As will be noticed, these values, which have been computed in Table No. V., are very constant for the same degree of expansion; we have selected, for the purpose of comparison, the two engines *A* and *E*, as they illustrate a greater difference of pressure between the beginning and the end of expansion. We stated above that the expansion of the steam, according to the law of Mariotte, is such that the pressures are in the inverse ratio of the spaces occupied at the beginning and the end of expansion respectively. This ratio is given in Table No. V. as the true ratio of expansion, taking into account also the clearance spaces; it amounts to 0.26 and 0.18 respectively, while the ratio of the corresponding steam pressures is 0.42 and 0.28 respectively. In the same measure, also, the actual curve, as drawn by the indicator, will be above the theoretical curve laid down by the law of Mariotte.

Finally, the following table, No. VI., contains the mean ratios between the initial and final pressures during the period of expansion for various degress of suppression. Here, again, a material difference will be noticed between the true ratio of expansion and the corresponding pressures; the amount of departure of the actual pres ures from the theoretical curve bearing, however, a certain relation to the degree of expansion, as will be seen presently. There are various causes which produce this action during the period of expansion, but their precise influence is more or less difficult to ascertain. In the first place, leakage at the valves or past the piston is, of course, calculated to alter the actual expansion curve. In the engines experimented upon by Professor Bauschinger,

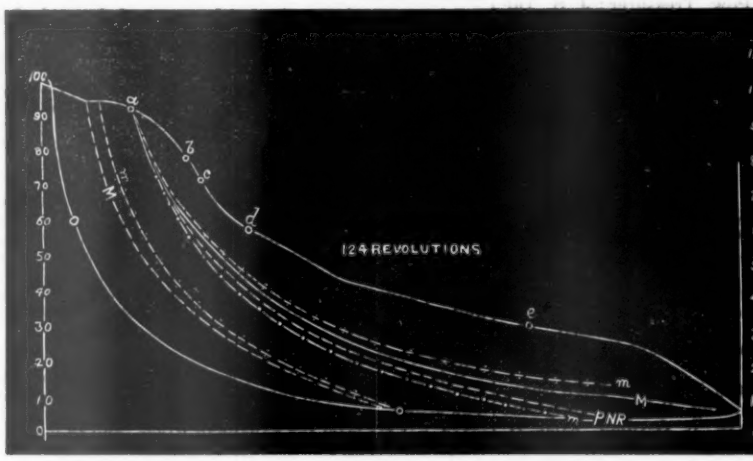


Fig. 23.

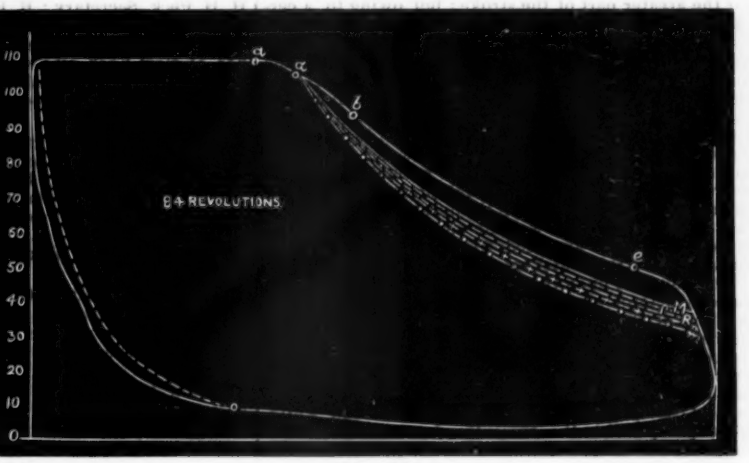


Fig. 24.

TABLE V.

Class of engine.....	Period of admission in per cent. of stroke.....	True ratio of expansion.....	Reference number of diagram.....	Number of revolutions per minute.....	Pressures above the atmosphere in pounds per square inch. In boiler.....	Pressures above the atmosphere in pounds per square inch. At beginning of expansion.....	Pressures above the atmosphere in pounds per square inch. At end of expansion.....	Ratio of absolute pressures.....	Mean ratio.....
A....	16	$\frac{2.76}{10.67} = 0.26$	15a	142	116	102	34	0.49	0.42
			14	125	114	103	33	0.41	
			11	147	113	89	28	0.41	
			37	124	98	90	28	0.41	
			13	119	94	84	26	0.41	
			12	124	117	103	34	0.43	
			29	136	106	76	23	0.42	
			30	133	111	70	21	0.42	
			28	120	85	73	21	0.41	
			28	140	83	73	23	0 43	
			39	134	105	65	18	0 45	
			41	117	111	54	14	0.42	
			40	147	88	43	9	0.41	
			43	115	114	30	4	0.42	
			23	120	107	98	33	0.43	
			8	149	72	49	14	0.45	
			4	144	71	33	6	0.44	
			13	146	92	51	12	0.41	
			10	139	90	70	21	0.42	
			6	137	71	31	14	0.44	
			16	137	73	65	17	0.40	
			15	133	80	59	16	0.42	
			18	129	85	73	25	0.45	
			20	126	93	82	25	0.41	
			19	122	73	65	20	0 44	
			16b	148	86	81	10	0.26	
E....	12.6	$\frac{1.945}{10.775} = 0.18$	15	121	80	73	9	0.27	0.28
			14	83	77	71.5	10	0.29	
			24	123	78	67	7	0.27	
			30	122	78	64	6	0.26	
			23	109	86	74	10	0.28	
			38	107	62	50	4	0.99	
			22	109	66	19	–6	0.27	
			32	107	85	78	10	0.37	
			36	155	57	47	2.5	0.26	
			31	144	81	69	9	0.99	
			33	132	83	65	8	0.29	
			39	179	58	41	3	0.32	
			34	169	70	9	–8	0.39	
			40	159	71	22	–5	0.37	
			35	156	69	14	–7	0.28	
			37	504	98	43	2.5	0.30	

TABLE VI.

Class of Engine.	Number of notch.	Period of admission in per cent. of stroke.....	True ratio of expansion.....	Number of indicator curves taken.	Ratio of pressure at beginning and end of expansion.....	Nature of work.
A	1	16	0.26	14	0.42	Goods train
	2	23	0.33	5	0.46	"
	3	33	0·40	11	0.58	"
	4	38	0 52	10	0.57	"
	5	47	0.59	1	0.69	"
B	1	19	0.37	11	0.48	Passenger train
	2	26	0.43	18	0.53	"
	3	34	0.49	8	0.56	"
	4	44	0.58	1	0.64	"
C	3	36	0.50	4	0.55	Express train
	4	42	0.54	7	0.63	"
	5	49	0.59	6	0.68	"
D	2 hind	14	0.27	14	0.49	Goods train
	2 front	27	0.39	14	0.47	"
	3 hind	21	0.34	40	0.47	"
	3 front	35	0 46	40	0.53	"
	7 hind	53	0.63	3	0.66	"
	7 front	66	0.70	2	0.70	"
E	1	12.6	0.18	17	0.38	Express train
	2	15	0.20	8	0.34	"
	3	21	0.26	5	0.39	"
F	3	28	0.34	5	0.42	Goods train
	4	36	0.43	12	0.48	Passenger train
	5	47	0.53	9	0.53	"
G	1	30	0.34	16	0.41	Goods train
	2	39	0.43	7	0.49	"
	3	57	0.60	17	0.62	"
H	1 II.	18	0.21	2	0.37	Mixed train
	2 "	21	0.28	4	0.35	"
	3 "	30	0.38	7	0.42	"
	4 "	38	0.45	5	0.48	"
	5 "	13	0.50	4	0 51	"

* We have given in the text the results arrived at by Professor Bauschinger, but, after a careful examination of the indicator diagrams to which he refers, we cannot but arrive at the conclusion that, in some cases, at all events, the "distribution diagrams" employed by him did not represent the action of the valve gears with the accuracy which was desirable. The diagrams shown by figs. 5, 6, 7 and 8, on page 289 of the present volume, are striking instances in point. The deduction we should be inclined to draw from a comparison of these diagrams with the corresponding distribution diagrams would be that there was a certain amount of looseness in the valve gear for which the last-mentioned diagrams made no allowance, and that hence the points of cut off and exhaust were both later than Professor Bauschinger has assumed them to be. A similar error would account for at least a portion of the discrepancy between the results deduced from Mariotte's law and those of actual practice, to which special reference is made above.

the valves and cylinder faces were accordingly examined, but they were found not only in good condition, but perfectly bright, so that no leakage could possibly have taken place; moreover, the effect of leakage, if such occurs, is generally easily detected by the irregular form of the indicator curves. The main cause of the peculiar action of the expanding steam is due, as the experimenters observe, to the heat given off by the cylinder to the contained steam after its communication with the boiler has been cut off. This condition is facilitated by the presence of a certain quantity of water, which, at the commencement of the expansion, has the temperature of the live steam, but as the pressure is reduced in the cylinder, this water will be instantaneously evaporated, and thus abstract from the cylinder a certain amount of heat. The heat absorbed with such rapidity is sufficient to raise the pressure considerably above that which would have existed had no condensation and re-evaporation taken place (see also curves of the theory of mechanical heat in diagrams figs. 23 and 24). The amount of heat which can be so absorbed depends, of course, upon the difference of temperature between the steam and the metal. On the other hand, the mean temperature of the cylinder is influenced by the amount of protection against radiation and conduction of heat from the cylinder, by the amount of "throttling" from the boiler to the cylinder, by the extend to which expansion has been carried, and by the speed in revolutions per minute.

When the communication between the boiler and the piston is open, the cylinder will acquire a temperature practically the same as that of the boiler pressure, and if the cylinder contain nothing but dry or superheated steam, this temperature would probably be maintained for the greater part of the stroke; but owing to a certain amount of water which has been deposited in the cylinder, and which is re-evaporated at the expense of heat imparted to the cylinder, this latter will become materially cooled by the time the piston has reached the end of the stroke. From these considerations the relative effect of various degrees of expansion and of speed will readily be appreciat d. As the degree of expansion is increased the quantity of water converted into steam becomes also greater, necessitating, however, a larger condensation of high-pressure steam during admisson; and the longer the duration of the stroke, in other words, the slower the engine is working the more heat will be absorbed from the cylinder by the conversion of this water into steam.

The influence upon the temperature of the cylinder of various meterological causes was felt during the greater portion of the experiments. Professor Bauschinger recommends that the cylinders should be better protected, in order to prevent excessive condensation, particularly in winter time. The difference of temperature between the two cylinder ends were also marked, in most cases, by the indicator; at the front end, which is badly exposed to the currents of cold air, the indicator curve was generally of a more depressed charac ter. The foregoing considerations lead to the concluclusion that in order to gain the benefit of expansive working it is essential to combine the element of high speed with some arrangement to prevent the condensation of steam during the admission. As it is, the cylinders of a locomotive are not sufficiently protected against the influences of the atmosphere and the chilling action of strong currents of air; the employment of superheated steam would be one mode of preventing condensation, but the same end may be better effected by the use of steam jackets. At all events, with a better protection of the cylinders against loss of heat, a direct gain in the power exerted by the engine, or a corresponding economy in respect of consumption of fuel, would be the inevitable result.—*Engineering.*

(TO BE CONTINUED.)

British Rail Exports.

The following monthly report of exports of railway iron from Great Britain, extracted from government returns, is furnished by Heyerdahl, Schœnberg & Co., No. 31 Pine street, New York:

TO	Month ending Aug. 31.			Eight months ending Aug. 31.		
	1869. Tons.	1870. Tons.	1871. Tons.	1869. Tons.	1870. Tons.	1871. Tons.
United States	25,548	41,076	47,998	229,145	279,616	335,162
Russia	36,532	23,152	11,095	159,049	163,700	65,634
Austrian Territories	1,737	2,179	6,607	21,184	26,308	15,241
British India	13,284	9,234	1,578	58,316	122,798	29,233
British North America	3,356	2,589	10,976	22,614	25,701	48,114
Egypt	670	2	898	6,025	1,566	2,429
Australia	1,686	727	630	15,827	6,123	11,382
Brazil	883	185	2,155	1,755	2,735	14,436
Holland	1,806	1,032	2,019	9,163	14,412	8,599
Spain and Canaries	2,846	6	153	10,449	9,463	6,511
Sweden	2	2	1,240	3,141	1,120	6,585
Chili	21	364	680	2,647	10,448	7,903
Spanish West India Islands	565	824	200	884	3,166	1,478
Peru	....	2,585	1,632	14,624	11,563	16,349
France	243	51	66	3,526	248	1,712
Germany	2,111	274	3,630	12,848	42,344	40,622
Other countries	10,186	3,950	6,767	49,091	37,822	51,461
Total	100,456	88,632	98,369	620,188	758,233	662,841
Total exports of iron and steel to all countries	274,918	223,802	319,741	1,802,461	1,962,431	2,072,173

Atchison Bridge.

General Wright, Chief Engineer of the Leavenworth Bridge, has established his office at Atchison and commenced surveys of the river banks preparatory to the letting of the contracts for the bridge. The time for the reception of bids has been extended to to-day—the 30th of September.

—The sleeping-car patent case of Pullman against Woodruff, for a preliminary injunction, will be heard at Pittsburgh on the second Monday in November.

General Railroad News.

ELECTIONS AND APPOINTMENTS.

—Since the election in Terre Haute, on the 21st inst., the directors of the Cincinnati & Terre Haute Railroad Company has been composed as follows: Alfred Pleasonton, New York; N. M. McDowell, Canton, Ohio; John D. Scully, Pittsburgh, Pa.; A. B. Quachenbush, do.; James B. Foley, Greensburg, Ind.; John and S. A. Burnett, Terre Haute, Ind.; James Small, Bloomington, Ind. The officers are Alfred Pleasonton, President; N. M. McDowell, Chief Engineer; John D. Scully, Treasurer; A. B. Quachenbush, Secretary.

—Gen. E. W. Serrell has resigned his position as Chief Engineer of the Connecticut Air Line Railroad, and Mr. —— Botsford has been appointed to succeed him.

—Col. D. C. Cross has been elected President, Q. K. Underwood, Treasurer, and J. C. Macabe, Secretary, of the Iron Mountain & Helena (Ark.) Railroad Company.

—At the annual meeting of the stockholders of J. W. Street's Palace Stock Car Company, held in Chicago on the 13th inst., the following persons were elected directors for the ensuing year: Gen. H. L. Stewart, Chicago; John W. Street, Chicago; D. M. M. Turner, New York; H. S. Munroe, Chicago; H. H. Peck, Chicago; Abner Peck, Mass.; J. S. Talmage, Ohio; Isaac Snider, Ohio; T. J. McCarty, Ohio; Robert Pow, Ohio; Jos. A. Kerr, Ohio; A. B. Pullman, Chicago; Wm. Jennings, Ohio. The following officers were elected: J. W. Street, President; D. M. M. Turner, Vice-President; H. H. Peck, Secretary; R. Pow, Treasurer; J. S. Talmage, General Agent. James Montgomery, of Chicago, retired from the Board and gave place to D. M. M. Turner, of New York, who was also selected for Vice-President in place of Mr. Montgomery. Mr. Turner has been for many years connected with the packing of beef and pork.

—The following directors of the Jacksonville & St. Augustine Railroad Company were lately elected at Jacksonville, Fla.: A. Huling, H. Jenkins, J. H. Durkee, F. A. Dockray, John S. Driggs and George R. Foster. Subsequently a meeting of the directors was held, at which General H. Jenkins was elected President of the company; F. A. Dockray, Secretary, and John S. Driggs, Treasurer.

—Mr. H. W. Holley, Chief Engineer, has been appointed also General Manager *pro tem.* of the Southern Minnesota Railroad, *vice* C. F. Wykoff, deceased. Mr. B. Lennox has been appointed Assistant General Manager.

—At a late meeting of the Michigan Lake Shore Railroad Company, the following directors resigned: H. C. Akeley, J. W. Converse, R. Gardner, Fred. H. May, Chester Warner. The following directors were chosen in their stead: Thomas A. Scott, Gen. G. W. Cass, J. W. McCullough, S. J. Tilden, Wm. Thaw. Joseph Fisk was elected President, *vice* J. W. Converse, resigned; W. R. Shelby, Secretary and Treasurer, *vice* A. J. Kellogg and E. P. Ferry, resigned; and P. S. Rourke was appointed Assistant Superintendent.

—The following directors and officers of the Indianapolis, Bloomington & Western Railway were elected at Urbana on the 20th: Directors—C. R. Griggs, William Dennison, B. E. Smith, D. Ricketts, Robert Turner, Wm. H. Smith, Henry Conklin, W. W. Phelps, George Nebeker, William Y. McCord, D. T. Thompson, J. C. Short, S. C. Willson; President, B. E. Smith; Vice-President, C. R. Griggs; Secretary and Treasurer, A. P. Lewis; Superintendent, Jas. S. Oliver; General Ticket Agent, J. W. Brown; General Freight Agent, H. C. Deihl.

—A conference of the State Railroad Commissioners with the managers of most of the railroads in Massachusetts was held in Boston on the 19th inst., at which the following committee was appointed to co-operate with the Commissioners, and report upon such additional safeguards to railroad travel as may be deemed necessary: Hon. John H. Clifford, of the Boston & Providence; D. Waldo Lincoln, of the Boston & Albany; John B. Winslow, of the Boston & Lowell; William Merritt, of the Boston & Maine, and Daniel L. Harris, of the Connecticut River railroads.

OLD AND NEW ROADS.

Chicago & Michigan Lake Shore.

Beginning with last Sunday, cars have run through from Chicago to Montague over the Michigan Central and the above railroad. One attached to the mail train leaves the Central Depot, Chicago, at 6 a. m., except Sundays, arrives at New Buffalo at 8:38 a. m., St. Joseph 10:00 a. m., Grand Junction 12:00 m., Holland 2:43 p. m., Nunica 4:25 p. m., Fruitport 4:50 p m., Muskegon 5:25 p. m., Montague 6: 5 p. m. One attached to the night express leaves Chicago at 9:00 p. m., Saturdays and Sundays excepted, arrives at Fruitport 8:10 a. m., Muskegon 8:40 a. m., Montague 9:30 a. m. A Pullman sleeping car runs through with this train from Chicago to Muskegon and Montague. On Sundays this car is attached to the Atlantic Express, leaving Chicago at 5:15 p. m. There is besides an accommodation train, which leaves Chicago at 4:00 p. m. and reaches St. Joseph at 8:00 p. m.

Chicago, Burlington & Quincy.

The contract for double-tracking this road from Aurora to Riverside has been let to D. L. Wells & Co. Mr. J. B. Brown has the work between Hinsdale and Riverside. The road is already double-tracked between Mendota and Aurora.

Michigan Central.

The Kalamazoo Accommodation will hereafter leave this city at 4:00 p. m., instead of 4:10. The 9:00 a. m. New York express runs over the main line, as formerly; the 5:15 p. m. Atlantic express runs over the air-line.

Michigan Southern.

Some changes in the time-table are to take effect to-morrow, but up to the hour of going to press the changes have not been announced.

Chicago & Northwestern.

The following are the stations and distances from Madison, on the Baraboo Air Line road, operated since the 17th as far as Baraboo:

	Miles.		Miles.
Madison	0	Lodi	19
Waunakee	10	Merrimac	26
Dane	15	Baraboo	37

One passenger train a day now runs to and from Baraboo, arriving there at 6:30 p. m., and leaving at 10:45 a. m.

Work is progressing quite rapidly on the Green Bay & Menominee Extension. Fifteeen miles of iron are already laid, and 15 miles more—which will complete the road from Green Bay to Oconto—are to be done by the 20th of October. The entire line between Green Bay and Menominee is to be ready for operation by January 1st.

Chicago, Burlington & Quincy.

The extension of the Mendota Branch of this road, which is to be completed from Prophetstown to Clinton Bridge by the 1st of January next, is located nearly on an air line between those two places. The country is quite rough and there are no towns on the route, though a station is to be located on an eligible site about midway between Prophetstown and Clinton. The distance is very nearly 17½ miles.

Northern Pacific.

A correspondent writes us from one of the exploring parties of the Middle Division of the Northern Pacific that lines have been run along the Jefferson and Big Hole rivers, in Montana, to Divide Creek, at Big Hole Mountain, at the north line of Beaver Head County, near the boundary line of Montana and Idaho. The heaviest work of the line is expected at this point, which is about ten or twelve miles from the summit. It is hoped to cross the dividing ridge at a grade not exceeding 50 feet to the mile.

Advices from Montana to September 15 state that the Crow Indians offer no opposition to the Northern Pacific Railroad, are perfectly willing it should be built, and, in fact, have volunteered to have part of their chiefs and head men accompany the engineers and soldiers, to aid scouts, and assist them in any way in their power against the Sioux.

Augusta & Hartwell.

It is announced that the general contractors for this road are prepared to sublet contracts for grubbing, etc. The road is to extend from Augusta, Ga., northwestward, not far from the Savannah River, and to make a connection with the Blue Ridge Railroad or other line crossing the mountains, for Knoxville, Cincinnati, Louisville, and the Northwest.

Rensselaer & Chicago.

Articles of association of the Rensselaer & Chicago Railroad Company were filed with the Secretary of State of Indiana on the 23d inst. The road is to run from the town of Rensselaer, Jasper County, Ind., through the counties of Newton and Lake, in that State, and Will and Cook counties, in Illinois, to Chicago, a distance of seventy miles. The capital stock is $2,000,000, of which $53,000 has been subscribed. R. S. D. Wiggins, J. M. Stackhouse, Thos. Burroughs, Alfred McCoy, Henry Weston, Marion L. Spitler, Ira W. Yeoman, Allen Yeoman, and Norman Warner constitute the Board of Directors.

Springfield & Mattoon.

The people of Springfield, Ill., are interested in a project to construct a railroad from that place a little south of east through Macon (on the Illinois Central 11 miles south of Decatur) to a junction with the Decatur & Mattoon Railroad a few miles east of Macon.

St. Louis & Iron Mountain.

The present southern terminus of the Arkansas Branch of this road is at a station called Piedmont, on McKenzie Creek, in the southern part of Wayne County, about 40 miles south of the junction with the main line at Bismark, and 17 miles from the late terminus at Annapolis. This station is in the midst of pine and hardwood forests, and considerable lumber is manufactured in the vicinity. The railroad is to have a round-house and repair shops at this place, which is 116 miles from St. Louis. Work on the extension of the road down the Black River toward the Arkansas line is quite heavy, but is progressing favorably.

Jacksonville, Pensacola & Mobile.

The Quincy (Florida) *Journal* announces that nine miles of iron has been laid from Quincy, the present western terminus, westward; 450 tons of iron for the road were lately lost at sea by the foundering of two vessels; but for this loss, which will occasion some delay, the road would have been completed to the Apalachicola River—21 miles west from Quincy—by the 15th of October.

Gilman, Clinton & Springfield.

Trains are now running regularly over this road from Gilman to Mt. Pulaski, in Logan County, about 20 miles from Springfield. The road is completed to Springfield and trains will run regularly to that place next week. The machine shops have been located at Clinton.

Boston & Maine.

An exchange paper says that this company has located an extension to within three miles of Portland, leaving North Berwick, three-quarters of a mile from the Portland, Saco & Portsmouth depot. It crosses Maryland Ridge at Wells, goes within one and a half

miles of Wells Beach and the Atlantic House, passes midway between Kennebunk and Kennebunkport, thence parallel with the Portland, Saco & Portsmouth road to Biddeford and Saco, going through these cities, thence down close to the Ocean House, on the Old Orchard Beach, thence to the sea shore, crossing Nonesuch River two miles from Scarboro Beach, and three-quarters of a mile from Oak Hill Station, on the Portland, Saco & Portsmouth road, and thence to the Cape Elizabeth line.

New York & Oswego Midland.

The important Shawanugunk Tunnel, near Middletown, N. Y., was opened through on the 19th inst., and it is expected that trains will pass through it by the 1st of January.

Toledo, Peoria & Warsaw.

The grading of the Burlington Branch of this road—from La Harpe to the Burlington & Quincy road—was to have been completed on Tuesday of the present week. Track-laying has already begun and will probably be finished by the 5th of October.

Decatur & State Line.

There will be a meeting of the stockholders of this company at the office in Chicago, at 10 o'clock a. m., on Monday, October 2.

Laclede & Fort Scott.

The contract for constructing this road has been let to George A. Fitch, of New York; Wm. J. Budd, of Missouri; John Fallon, of Philadelphia; O. L. Grant and Chas. W. Cole, of Chicago; A. Mason, of Boston, and George Mackey, of New York. These gentlemen have associated themselves under the style and title of the "Laclede Contractors."

Quincy, Alton & St. Louis.

This road was completed on Thursday of last week to a point about 21½ miles south of Quincy. The line runs south from Quincy, keeping about one-half mile east from the Mississippi River bank to nearly opposite Hannibal, where it curves southeastwardly, crossing the Hannibal & Naples road at Hill's Station, 2½ miles west of Kinderhook. The track is laid 2½ miles south from the crossing. The distance from Quincy to Louisiana—to a point opposite which it is expected the road will soon be completed—is 42 miles.

Osage Valley & Southern Kansas.

The Osage Valley & Southern Kansas Railroad is advertised to be sold in St. Louis on the 16th of October, to pay the interest now due on the bonds, amounting to about $20,000. Boonville is at present its northern terminus, and Warsaw, in Benton County, is its southwestern. Before the late civil war the road was nearly graded from Boonville to a point about ten miles south of Tipton, but the war coming on, operations were suspended until 1867, when additional aid to the amount of $175,000 was furnished by Cooper County, and $23,000 by Willow Fork Township of this county, the work was resumed and the road-bed completed an ironed between Boonville and Tipton, a distance of twenty-six miles. In 1868 it was leased to the Missouri Pacific Railroad Company for a term of thirty years, they paying 35 per centum of the gross earnings of the road, since which time that company has operated it. The sale in no wise affects the Pacific Company's lease. The interest in that part of the road south of Tipton was also revived in 1868 by the people of Morgan and Benton counties, the former subscribing $100,000 and the latter $200,000, which sums have been expended in the grading of the road throughout those counties. The road is graded to Versailles, in Morgan County, and also about twenty-five miles in Benton County, leaving yet to be graded that part of the road from Versailles to the Benton County line, a distance of fourteen miles, and about six miles in Benton County.—*St. Louis Journal of Commerce.*

Iowa & Minnesota.

This railroad is under contract from Fort Dodge northeast 55 miles to Garner, a station on the Iowa & Dakota Division of the Milwaukee & St. Paul Railway, 21 miles west of Fort Dodge. On that part between Fort Dodge and Clarion, 28 miles, grading is commenced, and work is soon to begin on the rest of the line.

Port Huron & Lake Michigan.

It is reported that sufficient iron has been received to complete 20 miles more of this road from its present western terminus at Lapeer to Flint, Michigan.

Quincy, Missouri & Pacific.

The track on this road is laid from Quincy northwestward across the Tabius River Bridge, and some distance beyond it. The grading is very nearly done to Edina, and ties are being delivered all along the line.

Fredericksburg & Gordonsville.

The franchises, rights, real estate and personal property of every kind, nature, and character, belonging to this company, will be sold at public auction in New York December 28 next, by order of the Farmers' Loan and Trust Company, who are the trustees of the one million first-mortgage sinking-fund seven per cent. gold bonds of the company, who have defaulted in the payment of the interest due on November 1, 1870, and on May 1, 1871. The road is sixty-one miles long, extending from Fredericksburg, Va., to Gordonsville, Va., but only a small part of the line has been done.

Mansfield, Coldwater & Lake Michigan.

Eleven miles of this road is just completed from Allegan eastward to Monteith, where connection is made with the Grand Rapids & Indiana Railroad.

Havana, Mason City, Lincoln & Eastern.

We are informed that contracts were let last week for building this road from Havana to Urbana—the work to be completed by the 1st of September, 1872.

Kansas City, Memphis & Mobile.

The Jefferson City (Mo.) *Times* says: "At a recent meeting at Clinton, Henry County, all the different lines of Memphis railroads were extinguished, or consolidated into one grand trunk road between Kansas City and Mobile. Both of the 'Clinton branches' of the Tebo & Neosho Railroad went out of existence, and a new organization was effected, uniting all into one company, to be known hereafter as the Kansas City, Memphis & Mobile Railroad. The new company intends making this a narrow-gauge road, with an extra or third rail laid down between Kansas City and Harrisonville, for the accommodation of the Missouri, Kansas & Texas Railroad. The work upon the Memphis road south of Clinton has been pushed forward at a surprising rate. The ties are all upon the line between Clinton and Osceola, and the iron is all *en route*, and engines and rolling stock ordered. Trains will be running between Osceola and Clinton during next October."

Denver & Rio Grande.

This road is now completed for 43 miles, and its completion to Colorado City (near Pike's Peak) is promised by the middle of October.

International Railroad.

A Texas paper announces the first shipment of cotton over this road, which arrived at Hearne, Texas, the junction of this road with the Houston & Texas Central, on the 13th inst. It is expected that the section now completed will have a fine business this fall and winter.

Concord Railroad.

There have been added to the equipment of the line since the 14th of last January six new passenger cars, three new locomotives and seventy-one new eight-wheel freight cars. Thirty more freight cars will soon be completed, and a further lot of fifty will be constructed during the winter, thus making in all an addition of one hundred and fifty-one freight cars for the railroad fiscal year ending March 31, 1872. The addition to the rolling-stock of the corporation made from March 31, 1866, to March 31, 1870, a period of four years, were four locomotives, three passenger cars, one hundred and thirty-nine eight-wheel freight cars and twenty four-wheel crate cars.

White Mountains Railroad.

The contract for building the extension of this road—which is operated by the Boston, Concord & Montreal Company—from Lancaster to Northumberland, 10 miles, there to connect with the Grand Trunk Railway, has been awarded to S. S. Thompson, of Vermont, and John Lindsey, of Lancaster. Work was commenced on Monday, of this week, and is to be completed by the 1st of July next.

St. Louis, Alton & Terre Haute.

A large number of the preferred stockholders of the St. Louis, Alton & Terre Haute Railroad Company met at the company's office, No. 12 Wall street, on Tuesday, September 19, to confer together in regard to the dividend due on the stock for over two years. Mr. O. D. Ashley was called to the chair, and G. H. Watson appointed Secretary. It was stated that the company had earned in the two years over ten per cent. net, and, according to the agreement of the preferred stockholders, this money should have been paid in dividends to the stockholders, but had been used in assisting the Bellville Railroad Company. After some further remarks, which were unanimous in asking the directors to declare a dividend in preferred stock equal to net cash earned, a committee of five was appointed to confer with the directors, and to report at a future meeting the expenses of the road for the last two years, and what the money had been expended for. It was hoped that the directors would declare this dividend legally due without recourse to the law by some of the prominent stockholders.—*Commercial and Financial Chronicle.*

Connecticut Western.

This railroad, which was opened recently as far east as Winsted, is to be completed by the end of November to Hartford.

Delaware, Lackawanna & Western.

The New York *Times* says: "The Morris & Essex Division of the Delaware, Lackawanna & Western Railroad has recently been the scene of material improvements, which have commanded the admiration of the people who travel, and those who are interested in the quick and safe transportation of freight of various kinds over the road. A large force of men have within a short time past been busily engaged under the experienced supervision of the superintendent of the line in altering the grades along the line of the Morris & Essex Division. This alteration of the grades is a work of considerable dimensions, but it is being pushed forward with considerable dispatch and the work being done well, and with a view to solidity. Upon the completion of it the Morris & Essex road will vie with any in the generally superior character of its appointments. The stock of the road is in fine condition, and abundantly large for the great patronage it receives. The workshop, which is situate just outside of Hoboken, is spacious, and gives employment to a small army of mechanics. Just at present the work at this shop is very active, and the construction of new cars is going on with dispatch. A very large amount of raw material is on hand and is being used up with rapidity. This road has but recently had the advantages of the broad gauge, which gives great satisfaction to the company and to its patrons. Both the broad and narrow gauge are used on the division. A new track is being laid along the line by a large number of laborers, who are extending the road-bed to some extent."

Grand Trunk.

It is reported that this company will soon have a track of standard gauge between Sarnia and Buffalo, thus enabling it to take cars through from the West to the latter place. This will be done, probably, by laying a third rail between Sarnia and Stratford, but on the Buffalo & Lake Huron road there is little need of the 5-feet 6-inch gauge and it might be reduced without disadvantage.

Lafayette, Muncie & Bloomington.

The Lafayette *Courier* of last week says: "There were received here last week one hundred and thirty-seven cars of railroad iron, thirteen cars of splices, bolts and spikes. The bridge over the Wabash River will be completed this week. The track-layers will be at work to-morrow, and the work will be pushed forward with the utmost vigor."

Sale of the Delinquent Tennessee Railroads.

A large number—probably the largest number—of the railroads of Tennessee were constructed in large part from funds advanced by the State. Since the war, few of these railroads have paid the interest on their debts to the State, and, in consequence, four of these were sold at public auction in Nashville on the 20th inst., to satisfy the State's claims. The Nashville *Banner* of the 21st inst. gives the following account of the sale:

A large crowd of capitalists and representatives of railroads attended the sale of delinquent railroads on the eastern side of the Capitol at noon yesterday.

The Knoxville & Charleston Railroad was knocked down by Auctioneer Dolin to the Blue Ridge Railroad at $75,000; the Rogersville & Jefferson to the East Tennessee, Virginia & Georgia Railroad at $10,000; the Knoxville & Kentucky to W. B. Johnston and others at $300,000, and the Western & North Carolina to E. Simerly, on behalf of the stockholders, at $12,500.

Some very spirited bidding occurred between W. B. Johnston of Macon, and J. R. Jones, of Atlanta, for the Knoxville & Kentucky Railroad, there being ten bids ranging from $100,000 to $300,000.

It was announced that the Nashville & Northwestern Railroad would be sold at 2 p. m., but upon the arrival of that hour it was determined by the Commissioners to postpone the hour to 3 p. m. to-day, with the intimation that it might be sold at that hour. The sale, we understand, depends upon the withdrawal of the *certiorari* and *supersedeas* granted to Davidson County, which is intimated as probable

After the sale had taken place the Commissioners retired to the Comptroller's office, and, after consultation, refused to confirm the sale of the roads mentioned, on account of the poor prices obtained.

A modified decree was entered in the Chancery Court relative to the Memphis, Clarksville & Louisville Railroad, in which several points objectionable to the purchaser of that road (the Louisville & Nashville Railroad) are equitably settled. The result will be that the purchaser will turn over to the Comptroller $1,700,000, the premium price fixed.

The next issue of the *Banner* has the following additional information concerning the action of the State Commissioners:

The State Railroad Commissioners held a meeting at the Comptroller's office yesterday morning, to take action concerning the delinquent railroads.

The firm of W. N. Wright & Co. withdrew their proposals to purchase the Winchester & Alabama Railroad in favor of W. J. Wicks and James Donegan. The latter were accepted as the purchasers. They made the first payment of $75,000 in bonds, and gave a substantial bond for the payment of the balance of the purchase money. The Commissioners reported the sale to the Chancery Court for its confirmation. The question as to whether the $200 000 bonds, which Messrs. Wicks & Donegan proposed to pay for the road, shall go to the members of the firm of W. N. Wright & Co., or to the stockholders, will be left to the decision of the Chancery Court at Winchester. The sale will, it is believed, be confirmed to day.

The Commissioners will report the sale of the Edgefield & Kentucky and the Southwestern railroads to the Chancery Court for confirmation to-day.

Colonel McGhee, representing the East Tennessee, Virginia & Georgia Railroad; Colonel Trescott, of the Blue Ridge Railroad Company, of South Carolina; Colonel Fleming and Edward Baxter made arguments and submitted reasons why the bids on the Knoxville & Charleston, Knoxville & Kentucky, Rogersville & Jefferson and the Western North Carolina railroads should be accepted; but, notwithstanding the fact that the Commissioners do not wish to be oppressive as to the terms upon which the above roads shall be sold, they do not think the bids sufficient to justify the State in accepting them.

We understand that William B. Johnston represented the East Tennessee, Virginia & Georgia and the Western & Atlantic railroads in making the bid for the Knoxville & Kentucky road, and James and Swepson, the former a banker at Atlanta, and the latter President of the First National Bank at Knoxville were the opposing bidders. Col. Trescott represented the Blue Ridge Railroad Company, of South Carolina, in the bids for the Knoxville & Charleston Railroad.

The Cincinnati, Cumberland Gap & Charleston Railroad, the minimum price of which has been fixed at $700,000 in bonds, will be sold October 8, the time granted to its stockholders for its purchase expiring at that date.

The final sale of the McMinville & Manchester Railroad will be made within the next twenty days, further time having been granted the stockholders in which to settle several preliminary matters.

The bonds for the purchase of the Memphis, Clarkesville & Louisville Railroad will be turned over to the Commissioners during this or the earlier part of next week.

The special train which was sent over the Nashville & Northwestern Railroad on Wednesday to bring the directors living along the line to Nashville, with a view to holding a meeting here relative to the withdrawal of the *certiorari* and *supersedeas* granted by the Supreme Court to Davidson County, arrived at 8:30 yesterday morning. Mr. Hawkins, the President of the company, who is said to be opposed to the withdrawal of the writ, and who had only the power to call a meeting of the directors, left here for his home early yesterday morning, *via* that road. Among those who came here

on the special train were several prominent stockholders. The reason which seems to be assigned for calling the directory together was, that the writ might be withdrawn and the road put under the hammer and sold. An informal meeting, composed of twelve directors and stockholders, was held at the office of the Commercial Insurance Company, but no definite action was taken.

Cincinnati, Richmond & Fort Wayne.

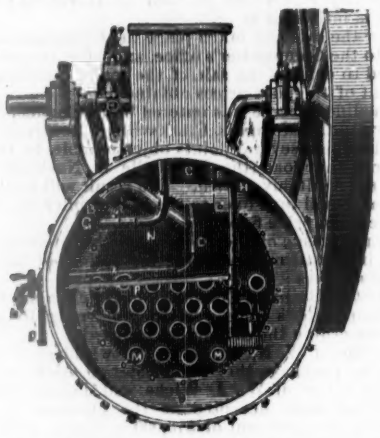
This track was completed on the Northern Division of this road on the 26th inst. to the south line of Allen County, nine miles south of Fort Wayne, and the rails are going down so fast that by the middle of October it is expected that Decatur, 25 miles from Fort Wayne, will be reached.

MECHANICS AND ENGINEERING.

Feed-Water Heaters.

Mr. James Thom writes as follows to the *English Mechanic:*

"The design of feed-water heater I herewith inclose has been patented by a Bristol firm, and is, I think, a very good one. The drawing represents the smoke-box end of a portable engine, with the cover removed, showing the construction and arrangement of the heater. As is well-known, a vast amount of heat escapes up the chimney of every engine, both from the tubes and the exhaust steam pipe. By the combined action of these waste heats the water can be rendered boiling hot before it passes into the boiler, and a considerable saving of fuel thereby effected. A large quantity of the escape steam is also condensed and returned to the feed tub, the quantity of water required being considerably reduced. The fire-box and tubes being subjected to less heat, also last much longer. By a reference to the letters on the drawing, and the description below, the action of the heater will be fully understood. *B, B, B,* is a tank or cistern 4 inches deep and 6 inches wide,



placed inside the smoke-box, between the wrapper and the outside circle of tubes, *M, M*; *A, A,* is the exhaust pipe, which, instead of going direct up the chimney, is passed round inside the tank *B*, coming out into the casting *C*, and then passing up the chimney in the usual way. The water is forced into the tank at the point *G*, through the pipe *N*, and then passes round the tank, coming out at *H*, being heated on the way by the hot exhaust pipe inside, which the water surrounds, and the heat from the tubes on the outside. The pump is kept continually going, and the boiler supply can be regulated by the tap, *K*. If shut, the water is forced into the boiler through the valve, *L;* if opened, it returns through the pipe, *P*, into the feed tub, warming the water therein. The condensed steam is collected in the casting, *C*, returning by the pipe, *D*, into the feed tub. I am told that an eight-horse engine, fitted with the patent heater, will work for ten hours at an expenditure of from 3½ to 4 cwt. of coal."

Steam Shovels.

A correspondent writes us, "Can you give me the address of parties who manufacture or furnish steam shovels for use in excavation on railroads." Would it not be well for parties who manufacture such machines to insert their cards in the GAZETTE?

Tree-Planting by Western Railroad Companies.

The following is a copy of a report made by Mr. H. W. S. Cleveland, a landscape gardener of Chicago, to the Superintendent of the Burlington & Missouri River Railroad, who has engaged Mr. Cleveland to supervise a system of tree-planting, along the line of that road between Lincoln and Kearney, Neb. This report was presented last July after examining the experimental plantations made along the line of the Kansas Pacific:

I returned yesterday from my trip over the Kansas Pacific Railroad, undertaken at your request for the purpose of examining the experimental nurseries which have been established at different points on the line of the road under the direction of the Industrial Agent of the company, Mr. R. S. Elliott, Esq.

The nurseries already under cultivation are three in number; the first at Wilson, 239 miles west of Kansas City; the second at Ellis, 302 miles, and the third at Wallace, 422 miles, which is nearly in longitude 102° and but a short distance east of the western line of Kansas.

The two first-named stations (Wilson and Ellis) are nearly in the same meridian as the western terminus of your line in Nebraska, and the third (Wallace) 183 miles west of Wilson, with an elevation of 3,200 feet above the sea, a region very much more arid and forbidding in its appearance than any portion of the extension of your line from Lincoln, Neb., to Fort Kearney, which I passed over with you the week before. As the experiments at this point are more interesting than the others, in proportion as the obstacles to be encountered are greater, it will suffice to give an account of what has here been actually accomplished.

Mr. Elliott's object has been to prove, not that trees may be made to grow by means of irrigation and careful culture, such as they would receive in a commercial nursery, but to discover what varieties will thrive and take care of themselves with the careless planting and management they are liable to experience from the average farmer. The means at his disposal have been inadequate to the accomplishment of careful work on an extended scale. His only force has consisted of two laborers inexperienced in nursery culture, with the necessary teams and tools, and these have had to be transported as required between the different stations at which he was operating, whose extreme distance apart is 183 miles. He has ten acres fenced and under culture at each station.

At Wallace the ground was broken up last September to the depth of 6 or 8 inches, and lightly plowed again this spring, and the seed and young trees sown and planted without further preparation, and with little subsequent care, and with no artificial irrigation, the ground being the high dry prairie, covered with the usual short buffalo grass, now almost turned to hay. The trees were two years old from the seed when planted. Many of them would doubtless have done better had they been shortened in to one or two buds when planted, and I am entirely confident that all would have been greatly benefited by a thorough mulching of the ground, the material for which could have been procured by mowing the bulrushes and rank grass which are occasionally found in the wet ravines of the prairies; but the experiments are all the more valuable and interesting from the fact that no such adventitious aid has been sought.

As a whole, every experienced tree-planter would acknowledge that the success is beyond what might reasonably have been expected, and equal to what any but a very sanguine man would have hoped, and the result is such as to encourage the utmost confidence for the future. Eighteen varieties of deciduous trees, and seven of evergreens were planted, of which I made my notes as follows, after careful inspection:

Of black walnut, forty-seven trees had been planted, all of which were alive and looking healthy, with young shoots a foot long. With one or two exceptions, this was the smallest number that had been planted of any one variety, most of the others comprising several hundred of each kind. Ailantus had been very largely planted, and may be placed at the head of the list for vigor and health. Its growth was such as would have done credit to any locality; and I was afterwards told at Denver that it was the only tree that would thrive there without irrigation, the elevation being 5,200 feet. It is a rapid growing tree, and its timber is said to be very durable. It seems, therefore, to promise to be of great value for prairie planting. White ash had also been largely planted, and had made vigorous and healthy shoots a foot to 18 inches in length and seemed in all respects healthy, though it had suffered somewhat from the attacks of a large green worm which has now appeared. A black beetle about an inch and a half in length, (known as the "blister beetle") had also eaten the foliage of all the above named, and threatens to be a disagreeable enemy. Catalpa has proved one of the most promising trees, notwithstanding the apprehensions which were felt that its broad leaves would render it peculiarly susceptible to injury from the prairie winds. This also is a rapid growing tree and its timber is very durable in the ground.

Box Elder (Negundo, or ash-leaved maple)—perfectly healthy and vigorous.

Osage orange, do., do.

Elm, healthy with shoots a foot long.

Willow healthy, but badly injured by prairie dogs, which had gnawed off and eaten young shoots and foliage. Some other varieties, also, were thus injured, but the willow worse than any.

Soft maple grows well, but the foliage is badly injured by the winds. The cotton-wood does better, and is in itself a more valuable tree.

European sycamore makes a poor show; may do better another year.

Tulip tree; prospects not encouraging. Linden tree ditto.

Chestnut apparently a total failure, though at Wilson its prospects are more encouraging.

European larch; a large number of these had been planted, of which hardly one in twenty was alive. Those which are living, however, afford good evidence that they will prove successful and that the only difficulty is in starting them properly. The trees in question were two years old from the seed when planted. They were not shortened in at all, and were hurriedly planted during the prevalence of a high dry wind. To any one familiar with the larch and its requirements, the result will not be surprising. Those which lived have made healthy shoots from three to six inches in length.

Of the evergreens, the most promising were the Scotch and white pines, which had made shoots of four to six inches in length. The Austrian pine and Norway spruce seem doubtful, and the Corsican pine and Lawson's cypress a failure.

All the trees above described were brought here from other nurseries. Besides these the experiment has been tried of sowing seeds of several different varieties, and this work also was rudely done in a style which any farmer might practice. Instead of sowing in sheltered beds, to be afterwards pricked out into carefully prepared ground, the seed of ailantus, osage orange, elm, honey locust, and cottonwood were sown broadcast on ground plowed as I have described, and simply harrowed in, and left to take care of itself. Here again the ailantus took the lead, and in fact, distanced all competitors. The young plants stood more thickly upon the ground than would be required for their best development as timber trees, and looked in all cases as if they had nothing to complain of, being an inch or two in height, and of rich, healthy color of foliage. The other seeds had germinated occasionally here and there, but by no means to compare with the ailantus, though it is not improbable they may germinate next year.

Of cereal crops—wheat, rye, oats and barley had been sown—much had been destroyed by prairie dogs, and an unaccountable feature of their depredations consisted in the fact that portions of a field would be eaten to the ground as clean as if cut by a reaper, while that immediately adjoining was undisturbed. In these spots the growth was fair, the heads tolerably filled, and the grain plump and round, as the enclosed samples of wheat and rye will show.

No one who has any just appreciation of the importance of the great work of forest-planting on the plains—the success of which may be predicated upon the results of Mr. Elliott's experiments—will deny him the meed of praise he deserves as a public benefactor, for what he has already achieved. Unfortunately, however, only a small proportion of those who look upon his little nurseries as they pass them in the cars will realize the fact that they are but a modern instance of the oft-told story of Columbus' egg—which anybody could stand on end after he had shown them how. The results I have described go very far to establish the fact that trees will grow without irrigation on the great plains, and they furnish also very valuable testimony as to the comparative value of different varieties. If any varieties can be proved to do this the question of their capacity for cultivation is answered, for the introduction of screens, belts and forests is all that is required to enable more delicate varieties to flourish under their protection, and with their gradual increase will come the humidity of climate, which is all that is wanted to develope the agricultural resources of the whole region.

It seems incredible that the Kansas Pacific Railroad Company, after having proved by these experiments what they have it in their power to do, should fail to make a practical application for their own benefit of the knowledge thus acquired; but so far as I have been able to ascertain, they have no present intention of so doing.

Your task is very much easier and simpler than theirs would be. The whole line of the extension of your road through Nebraska is in a much more favorable soil and climate than the portion of theirs which I have described; and since seeing the result of these experiments I am more than ever confirmed in the conviction I expressed after going over the line of your roads, that any and every portion of your lands might be successfully planted with forest trees, and no investment could possibly be made with so certain a prospect of very large profits as an elaborate and extended system of tree-planting. The work should be begun by the immediate establishment of a primary nursery at a convenient point on the line for the propogation of trees. This should be fully provided with all the necessary appliances for the work, and placed under the charge of an experienced nurseryman, with a sufficient force of men and teams to cultivate a large tract. A large quantity of young trees, of the most desirable varieties, might be procured from other nurseries for first planting, and the work of sowing seeds of all desirable varieties should also be begun as soon as possible, with a view to furnishing future annual supplies of young trees to the secondary nurseries, which, from time to time, should be established along the line, and from which the plantations of forests should be annually extended.

The sales of young trees from these nurseries, and, after five or six years, the sales of spruce, larch and cedar poles for fencing stuff, which would be furnished from the necessary thinnings of the plantations, would more than defray all expenses of culture.

Every nursery thus established would form the nucleus of a settlement—the opportunity of providing themselves on the spot with trees, being in itself a strong attraction to settlers, and, after the lapse of ten years, your road might begin to supply itself annually with ties from its own plantations, the whole cost of which would have been fully covered. In addition to trees planted expressly to furnish timber, it would be easy and expedient to grow fruit trees for sale, and I would especially urge the experimental planting of many varieties of native shrubs and small-sized trees, such as sumach, elder, barberry, hazel, cornel, dogwood, ptelia, hornbeam, etc., etc.,—or even andromedas and whortleberries—some of which may very probably be found to spring up freely from seed, and it will greatly facilitate the growing of more valuable trees if the ground can first be shaded with bushes. I am perfectly confident also that thorough mulching of the ground will be found of almost as much value as irrigation as a means of preserving moisture and an even temperature of soil about the roots. I do not mean simply mulching about each tree, but covering the whole ground when they are planted with refuse vegetable matter of sufficient depth to keep down weeds and grass, and prevent the sun's rays from heating and baking the ground. The nurseries would naturally be established in the vicinity of the stations, and you could hardly expend money more judiciously than in a tasteful arrangement of trees and shrubbery about the stations themselves, so as to render them attractive and pleasing to travelers passing through on your line of road. Whatever tends to relieve the monotony of the arid plains excites at once a lively interest, and nothing could so effectually do this as the contrast afforded by such an oasis, and the evidence it would give of the possibility of cultivation.

My present object has been simply to report what I have seen, and the general conclusions I have drawn therefrom, and I shall at any future time be happy to aid in developing further details of a scheme of forest-planting, if desired.